SCIENCE

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CONTENTS

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ON THE CULTIVATION OF THE CLINICAL SCIENCES OF DIAGNOSIS AND THERAPY[1]

IN preparing this address some weeks ago, I had written the statement that the membership of this association had fortunately been spared by death from any diminution in its numbers during the past year; shortly before this meeting, however, the association has suffered the loss of two of its original members—Dr. John S. Billings and Dr. Francis P. Kinnicutt, and one of its associate members, Dr. Hugh A. Stewart.

We now enter upon the work of the twenty-eighth annual meeting. Each annual session begins with an address from the president, by by-law limited to half an hour, and by custom including, first, an expression of appreciation of the honor of presiding over the assembly, and, second, suggestions for the promotion of the welfare of the association and, more especially, for the adaptation of its functions to the ever-changing conditions of American medicine.

My first duty is, then, to give thanks. The president of the association would indeed be guilty of ingratitude were he to omit to thank his colleagues for the honor and distinction they confer upon him by his election. Even though the choice comes automatically in serial sequence to members of the council, to be chosen as this officer is an honor which an ambitious physician might well be willing to look forward to as a possible culminating event

[1] Address of the president before the Association of American Physicians, Washington, May 6, 1913.

in a life of distinguished service in the profession. In the present instance, the selection has obviously been made rather as an encouragement to future work than as a reward for past performance; I can only be grateful for the generosity shown me and for the powerful stimulus to worthy effort which such confidence begets.

Turning now to the work of the association itself, it is plain that the great changes which have taken place in medicine since the foundation of the society in 1886 have modified old needs as regards associations and created new ones. Our attention has been called repeatedly to the changing needs by our presiding officers, most emphatically, perhaps, by Dr. Councilman in 1904 and by Dr. Adami last year.

Methods of medical education in the United States have passed through a veritable revolution. The proprietary medical schools, useful enough in their time, became insufficient and have been largely replaced by medical departments of universities, privately endowed, or aided by the states. The laboratory disciplines, under the stimulus of the great advances of biology, chemistry and physics in the second half of the last century, have experienced an unprecedented expansion, and the army of medical teachers and investigators has thus been recruited by a series of new battalions, made up of men trained in pathology, bacteriology, physiology, psychology, physiological chemistry, pharmacology, anatomy, histology and embryology. Many of the teachers and investigators in these purely laboratory branches are men limited in clinical experience to their undergraduate training; some of them, indeed, have entered upon a career in these fundamental medical sciences, after a preliminary apprenticeship in laboratories of biology or chemistry without taking even an undergraduate course in medicine. Meantime a high degree of specialization has been taking place also in the clinical branches. With the advent of anesthesia and asepsis in surgery came the opportunity for unexpected divisions of labor in surgical fields, while the introduction of instruments of precision, and of the methods of pathology and bacteriology, of biology and chemistry, in the work of internal medicine led to the intensive development, by skilled workers, of its various special domains.

One result of the almost explosive progress in the purely laboratory branches, has been to place the clinical subjects, and especially internal medicine, in almost an embarrassing situation. Internal medicine is, of all the biological sciences, the one to which the largest number of other sciences contribute facts for application. Internal medicine is usually designated as one of the "applied sciences." But all the sciences, with the possible exception of mathematics, are largely "applied science." Thus, physics consists in part of applications of mathematics; chemistry of applications of mathematics and physics; biology of mathematics, physics and chemistry; physiology of physics, chemistry and biology, and so on, with avalanche-like increase of the sciences to be applied, until internal medicine is reached with all the laboratory subjects offering it their aid.

Now each of these sciences, though largely applied science, is compelled to grow in its own way; each science is creative and has to devise methods of its own; even when a new fact in a science basal to it is applicable, the application has actually to be made. Take physiology as an example. A new discovery in physics, or in chemistry, does not enrich physiology until physiology makes use of it; indeed it may long lie unapplied since its fruitful application in physiology involves a physi-

ological research. The number of physical, chemical and biological facts as yet unapplied to physiological problems is so enormous, and the number and powers of physiological workers relatively so limited that progress, though rapid, in physiology, can by no means keep pace with that of its underlying sciences, no matter how desirable this may seem.

The clinical subjects are similarly situated though in transcendent degree. It is almost a wonder that the clinician is not suffocated by the physical, chemical, biological, anatomical, physiological, pharmacological, pathological, parasitological and psychological facts which are being heaped upon him with clamor for their application. Moreover, the facts have arrived so suddenly that they find the clinician, in many instances, unable to understand them, much less to apply them. Certain chemical, physiological and anatomical facts the clinician of the last generation had, indeed, trained himself to apply by study in the post-mortem room, in the histological laboratory and in the laboratory for urinalysis. But recently, and all at once, the air has become thick with applicable facts of the most diverse origin, and only the younger clinicians have had opportunity for securing a training permitting of an understanding of even a part of them.

For some years past, students have been entering the clinics for instruction after three or four years of education in the methods and facts of the basal sciences from physics to pathology. They have been surprised to find, in many instances, their clinical teachers relatively unacquainted with the present-day content of the laboratory disciplines, and have often been astonished at the delay in attempting to apply in clinical studies facts of those laboratory branches which seem to them obviously applicable to the work of diagnosis and therapy. Such personal observations by students working in the clinics have been a sharp spur to clinical men, and have undoubtedly gone far toward accelerating the application of laboratory facts and methods in the study and treatment of the sick. At times, of course, criticisms have been too severe or unjust. Students are prone to be harsh critics; their "young hot blood tingles to be up and doing"; often they know little of the circumstances which delay progress. In certain regrettable instances students may even have been led by a zealous but ill-informed pre-clinical teacher to believe that the workers in the clinical branches are not to be regarded as "scientific," but rather as "merely practical" men. This is an attitude occasionally assumed—happily less often now than a few years ago—by representatives of various sciences to all sciences to which they contribute facts for application, that is, to all sciences except those which are basal to their own. I can recall the time when an occasional teacher of physics, or of chemistry, hinted that the representatives of physiology or of physiological chemistry were amateurish or unscientific because the work in these branches is subject to conditions often inconsonant with profitable measurement in dynes or with graphic representation of stereochemical conceptions. But the older may well profit from the criticism of the younger, even if it be arrogant or unjust. The veteran, when taken to task by the recruit, may be amused, but if wise, instead of being offended, he will listen and will try to rejuvenate himself. In any case, he will rejoice in the vigor and optimism of the youth, and a part of his reward will lie in the consciousness of helping to train a group of successors who will surpass him.

It has been interesting to observe the attempts which have recently been made more fully and rapidly to utilize the new knowledge in the underlying sciences for the furthering of the work of diagnosis and therapy in the clinics. On the one hand, the older clinicians have heroically endeavored to acquaint themselves with the new facts as they have appeared; and they have hastened to surround themselves in their wards and in the clinical laboratories with younger men, trained in the newer laboratory methods, men who could aid them in the work of clinically applying the new facts. And, on the other hand, several universities have recently appointed to important clinical positions men who have been trained predominantly in the laboratory branches and who have made their early reputation in pathology, physiology, anatomy or chemistry, rather than in the clinical sciences. In these instances, we see two methods used to overcome a great difficulty and both are laudable. Each of them has led to advances in clinical teaching and research, but each of them is subject to obvious disadvantages. In the one instance, the clinical problems may be in the foreground, but insufficient personal acquaintance with the newer fundamental facts to be utilized limits vision; moreover, the lack of machinery for the utilization of the newer knowledge hampers the organization of diagnostic and therapeutic investigation. In the other instance, there is a real danger of an underappreciation of the nature, significance and scientific importance of the problems of diagnosis and therapeusis as such; the clinical appointee especially when untrained, or only slightly trained, in clinical work, and previously nursed in a fosterage, perhaps unfamiliar with, or even mildly disparaging of, the work of the clinic and of clinicians, may feel actually ashamed to work at the bedside and in the laboratory at truly clinical problems, feeling that his former colleagues, to whom he may owe his appointment, will regard him as a scientific clinician only when he avoids researches bearing directly upon diagnosis and therapy and devotes his energies to the solution of non-clinical problems, the attack on which properly belongs to the laboratories of pathology, physiology or chemistry.

The situation is gradually righting itself. The non-clinical scientists realize better than they did what clinical work is and should be, and that workers in clinical branches should not be expected to leave their own fields to conduct other researches any more than the clinician can expect the anatomists or the physiological chemists to solve either the diagnostic and therapeutic problems of the clinic or the fundamental problems of physics and mathematics. All are acknowledging that the problems of diagnosis and therapy are tasks set by the patients themselves, that these living patients are, primarily, the objects of study of the clinical scientist. For this study a fine imaginative vision—properly schooled and rigidly controlled—is desirable. Patients must, in each generation, be looked at with fresh eyes, intellectualized partly by accurate training in the most recent clinical technique, partly by previous education in the methods, facts and hypotheses of the non-clinical sciences. It is gratifying that clinical men themselves, including those with extended training in one or more of the non-clinical sciences, are, more than ever before, recognizing the worth and dignity of diagnosis and therapy as sciences *per se*—that is to say, as bodies of knowledge to be increased, not merely as arts to be practised—sciences to be cultivated for their own sake as intensively, as proudly, and as enthusi-

astically as are the more basal sciences. And this is why clinical men are seeing to it that provision is made in the clinics themselves, not for the presence of patients only, but also for elaborate machinery for investigating them; they are demanding and equipping *in each clinic* a number of laboratories in which physical, chemical, physiological, pharmacological, bacteriological, psychological and other methods and facts can be directly applied by trained men in the diagnostic and therapeutic inquiries to which the conditions existing in the patients actually before them lead.[1] And, in addition to the more permanent staff, they are taking with them to the bedside and to the adjacent experimental laboratories of the clinic groups of medical students, trained in the basal medical sciences and making them responsible for the large amounts of routine work of which these students are capable while they are acquiring their early clinical experiences. To obtain proper facilities for clinical study and especially the multiple laboratories manned by skilled workers necessary in each clinic, not only will much money be required, but also an awakening of the understanding of the clinical men themselves, of non-clinical medical scientists and of hospital superintendents and trustees to the need. By many it is still thought that the laboratories of the non-clinical sciences can be called upon to do the laboratory work of the clinical sciences. By others, and especially by the superintendents of general hospitals (who are forced rigidly to limit the expenditure of money), the fallacy is still cherished that a "general clinical laboratory" in the hospital can best do the work of all the clinics for them. This, it seems to me, is a grave error. I am convinced that nothing short of multiple special laboratory divisions *for the direction of which each clinic is itself actually responsible*, will ever satisfactorily supply the needs. Any other arrangement will emasculate the individual clinics and paralyze research in diagnosis and therapy. It was for a precisely similar independence for physiology that Purkinje had his great struggle about the beginning of the last century. The university faculty, and the university Kurator put great obstacles in the way. They did not see why physiology should not use the other laboratory (anatomy) for the work. The Kurator sarcastically asked "where will it lead to, if every scientific branch demands its own laboratory?" Thanks to Purkinje's clear vision and his persistence, and through the influence of Goethe and Alex. v. Humboldt, physiology finally got its independent institute. Von Ziemssen recognized a similar need for the medical clinics and demanded a "clinical institute" for teaching and laboratory researches in addition to his hospital wards. Only after such salutary conditions as those referred to have been realized in the clinics, and have been maintained there for a time, can we hope to breed a generation of clinicians in any way approaching the next necessary and realizable type—a type resulting from the fusion of training in accurate clinical observation with training in the solution of clinical problems by experimental work in the laboratory. The goal stands clearly in the view of those of us who are familiar with the present conditions and are ambitious for the advance of clinical knowledge. That this goal is being rapidly approached should be a consolation to the generation of clinicians chafing under the limitations of the period through which we are passing, more than one member of which has felt keenly the truth of the adage that "the

[1] *Cf.* "The Organization of the Laboratories in the Medical Clinic," *Johns Hopkins Hospital Bull.*, 1909, XVIII., 193–198.

man who rings the bell can not march in the procession."

The state of affairs to which I have referred has, to a certain extent, been reflected in the membership, and in the programs of the meetings, of this association. In 1886, the membership was made up chiefly of clinicians with a sprinkling of laboratory workers. In 1899, of 118 members, some 18 were pure laboratory workers who saw no patients at all. At present of 131 members, some 32 are pure laboratory workers who do not see patients, and many more are largely engaged in experimental work. Of the associate members, from whom our new members are in the near future to be drawn, at least one third are men who do not study patients but are engaged entirely in laboratory teaching or research.

A glance over the program of the meeting of 1899 shows that three non-clinical and twenty-seven clinical papers were presented. Last year, the program listed some thirteen non-clinical and some forty-six clinical papers. Our program this year includes some fourteen non-clinical and some fifty-one clinical papers.[2] A large proportion of the papers classed as clinical are reports of combined bedside and laboratory work. Now, on the whole this must be regarded as a very gratifying showing, illustrating, as it does, the great expansion in our clinics of work by experimental methods, as contrasted with work by more purely observational and statistical methods.

None welcomes, nor confides in, the experimental method more, perhaps, than I, but the observational method also deserves ever new application in clinical work. Is it not conceivable that we may actually retard progress in diagnosis and therapy if we center investigation in our clinics and in their laboratories upon problems far removed from the conditions observable in the sick? May it not be desirable to plan that the experimental work in the clinics shall, for the most part, bear directly upon the problems of diagnosis and therapy (of course, in a wide sense, including etiology, pathogenesis and prognosis), and to arrange that the more fundamental physiological and experimental pathological inquiries be relegated to those laboratories, the particular business of which is to advance the sciences of general physiology and general pathology. Unless clinical men jealously guard their time, their interest, their energies and their materials in order to devote them to the advance of the clinical sciences, the progress of diagnosis and therapy must be slowed. Not that a clinician may not become so interested in pathology, physiology or physics as to make it justifiable for him to leave the clinic and occupy a non-clinical post. The clinics can only be proud to send occasionally a Helmholtz to physiology, as chemistry may be glad to contribute an Ostwald to philosophy. A man must go where his cerebral cortex leads him, be it from physic to physics, as in Helmholtz's case, or from crystallography to therapy, as in Pasteur's. Moreover, even in truly clinical investigation there will often be non-clinical by-products of great scientific value to which there can be no objection provided the main product corresponds to the aims of the clinical sciences. But, at this time, it would seem important to emphasize that researches in general physiology and in general pathology, valuable and desirable as they are for the progress of the medical sciences, as a whole, pertain to a field other than that which the clinics themselves should predominantly cultivate. May I illustrate by an analogy? Were our physiol-

[2] In making this arbitrary division into clinical and non-clinical papers I am guided by the direct relationship of the topic to the diagnosis and treatment of disease in human beings.

ogists to devote their time chiefly to the inquiries now pursued in the university laboratories of physics and chemistry to the neglect of their own physiological studies, the science of physiology would undoubtedly suffer. Now, none the less will scientific clinical work suffer loss if the men who are presumably cultivating the clinical sciences of diagnosis and therapy overlook their own legitimate problems, neglecting their clinical material to dissipate their time, and their energies, in the general or special non-clinical inquiries which properly belong to the more fundamental laboratories. The Wassermann reaction may be primarily worked out in a non-clinical laboratory, but the determination of its real significance for the diagnosis and treatment of disease demands, subsequently, long years of clinical research. Salvarsan may be made, and its spirillocidal power tested, in experimental non-clinical laboratories, but its application and value in the treatment of the different forms of syphilis are problems upon which the clinics have only begun to work —problems the full solution of which may be slow in following upon the initial non-clinical investigations.

And this brings me again to our membership and the programs of our meetings. The mingling of clinicians (who study patients and who do experimental work in laboratories on clinical problems) with non-clinical experimental workers is stimulating, I believe, to both and *I trust that this association will always contain both.* Certainly, our non-clinical members have been and now are the very flower of our association. It must be remembered, however, that the anatomists, the physiologists, the biological chemists and the pathologists and bacteriologists now have their special societies, but that practitioners, teachers and investigators of internal medicine have their principal representation in this association, and it has always been taken for granted that this association is mainly, though not exclusively, a society for workers in internal medicine (in the broad sense). In selecting new members, ought we not always to keep this main function of the association in mind?

Again, may we not do well to pay close attention to this main function in making up the programs for our annual meetings? There is a wide-spread and growing feeling among our members that the farther removed a paper is from the examination and treatment of patients, the more acceptable it is for the program. Able clinical men have told me that they find some of the papers presented at the meetings too far removed from the fields of diagnosis and therapy to be interesting or even intelligible to them. "Those who read these papers speak to us as in a foreign language" is a complaint I have more than once heard. Such a difficulty can not, of course, with a mixed membership, be wholly overcome. But something could, it seems to me, be done to remedy what careful consideration indicates is a real detriment to the fullest success of our meetings. Better suggestions than mine will, I hope, come from other members, but two possibilities occur to me. First, might we not, while accepting some papers in general physiology and general pathology, urge that they be of a character likely to enlist the interest of clinicians and that they be presented in a form easy to understand by men who have not worked upon the special subjects with which they deal; papers in general pathology and physiology of different content might better be presented in the societies of the physiologists and pathologists. Secondly, may it not be helpful to arrange the papers on the program in groups in some such way as that adopted

this year; an individual member could then attend particular sessions, or all sessions, according as his interest and activities are specialized, or more general. A glance at this year's program shows the broad scope of the combined interests of the members of this association; and this scope is sure to become still broader as internal medicine grows and specialization in its various subdivisions increases. Thus, before long, the problems of "social medicine" are likely to engage us more than they do now. And I should like, in closing, to refer for a moment to this topic. Society at present tries, for its own welfare, to educate all citizens of the state. It may soon decide to try also to maintain the health and efficiency of all. Should society so resolve, a great extension of the municipal, state and federal medical services would become necessary to prevent disease; and the present method of treating patients at their homes would, in all probability, be largely replaced by hospital treatment. And if health should come to mean more than mere existence without outspoken physical disease—to include an abundant vitality, the capacity for joyous activity and for successful adaptation to the environment—then society, to maintain the health of its members, would have to see to it that the children born inherit bodies capable of normal responses to environmental stimuli, and further, that the various environmental stimuli to which individuals are exposed are beneficial to them and not too injurious. Such an ideal campaign for health seems at present a mere dream. But some dreams are prophetic forerunners of reality, and if we are to judge of the future by certain signs in the present, say by the institution of the *Krankenkasse* in Germany and by the movement toward a national medical service as advocated by Lloyd George in England, it may not be long before we shall, in this country, too, be taking some important steps forward in "social medicine." And when the time for this is at hand, we can be sure that this Association of American Physicians will be ready to throw its influence in the direction most helpful to society as a whole.

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THE MEANING OF GRADUATE STUDY[1]

It was a pleasure to me to accept the invitation tendered through your vice-president to appear before you to-night to speak on "The Meaning of Graduate Study." That it is important to every member of this club to have an adequate conception of this matter is obvious, and I shall not take time to emphasize this fact. I should like to say, however, by way of preliminary, that it is also vital to the university and to the state that both you and all the people of the state should be clear and accurate in your judgment as to the true nature and character of graduate work. On this depends, to a large extent, the success of the university and the measure of service which it may render to its constituency. I hope that the way in which your graduate study is thus vitally related to the university and to the community at large will appear with appropriate emphasis before I have done speaking.

We shall best avoid mutual misunderstanding if I state at the outset the answer which I have in mind to the question, "What is graduate study?"

In the first place it is not a further extension of undergraduate study. It is something different, not merely in degree, but rather in kind. The change from undergraduate to graduate work should be as marked as that from the high school to the university. On passing from the lower to the higher the student goes into a new atmosphere. He finds what is to him a novel attitude and point of

[1] Address to the Graduate Club of Indiana University, December 10, 1912.

view. He begins to look at science and the whole body of knowledge with anointed eyes, and presently the entire structure assumes a new aspect. The student is to be congratulated if this is accompanied by a revolution in his own mind, in his ways of thinking. If these vital inward changes do not take place there is usually little reason for his continuing in graduate work.

All graduate study which properly deserves the name involves research either directly or indirectly. It consists of three parts which are to be developed simultaneously, not successively: (1) One acquires the detailed and specific knowledge needed for research; (2) one develops the spirit of inquiry and consecration to the task of extending the bounds of knowledge—the spirit which characterizes the man of research; (3) one is inducted into the actual labor of discovery, and thus begins to experience what is perhaps the profoundest pleasure of which our nature is capable. Graduate study which lacks any one of these three elements is essentially deficient; it is not taken into account in our discussion below.

But what is research? What gives to it its central place of importance? What are the materials upon which it feeds? Let us first answer the last question.

The man of research should be free to choose his material wheresoever he will. A directing authority would ultimately be fatal to his vitality and destructive of all useful labor. But he must exercise an intelligent choice. Out of the myriads of facts in the universe selection must be made. Some are irrelevant; and these should be discarded. To determine the number of sprigs of grass on the campus or to count the lady-bugs on our planet is not research. These facts—though facts they are—have no permanent character; they do not lead anywhere.

True research consists of any one or more of three kinds of work of equal rank, as follows:

1. Ascertaining new facts of a permanent character or drawing attention to new relations among facts already known. This requires the power to direct attention to things which other people have overlooked, to separate them from the mass of facts in which they are imbedded and to study them first for their own sake and then in relation to other things. The man of research requires the power to see the mosquito on the monument and for the moment to forget the monument for the sake of the mosquito. It is so often the trivial thing which turns out to be important. It is of more concern to us to know the mosquito which holds the power of life and death than to contemplate the battle commemorated by the monument.

2. Deriving the consequences of facts already known. No fact is thoroughly understood until all its consequences are brought into review or the possibility of doing this has been clearly and definitely recognized. Indeed it is only when this has been done that we can be said to have ascertained that the thing is a fact.

3. Developing a body of theoretical doctrine, with or without reference to facts to be accounted for by it. Under this head come such matters as the Mendelian theory of inheritance, the electron theory, the mathematical theory of electricity, projective geometry.

Granting now this definition of research and its fundamental relation to graduate study as outlined above, the question arises as to when the student should begin the actual work of research. Should it be in the first year? Or, should one await a longer period of preparation in order to be better fitted for it? Probably no other subject requires as much preparation for research as mathematics, because in this the whole body of doctrine is closely connected and interdependent. Many extensive parts of it can be learned in essentially only one order. One may compare it to a tree. The trunk corresponds to the fundamental parts of the subject, the branches are the subdivisions, the remoter twigs are boundaries of present knowledge, and it is here that new truth is principally to be developed. Before one is ready for research he must ascend the trunk, so to speak, and climb out along some

vigorous branch to the twigs near its end. All this takes time. And yet, if my short experience is not misleading, this may be tentatively accomplished even in the first year of graduate study. To be sure, such early research is crude; it could hardly be otherwise. Probably one should seldom allow it to see the light of day, so far as publication is concerned. And yet to do such preliminary research is a matter of importance to the student. The power of independent thinking depends first of all on a certain natural aptitude, but it is capable of cultivation. The way to develop this power is to exercise it; and the sooner one begins the better. Too much acquisition and too little discovery undoubtedly benumb the faculty of initiative.

But how is one to get started on research with some promise of successful achievement? Is there a guide who can induct him infallibly into the inner secrets of the creative power? Fortunately or unfortunately, there is no flowered path leading through fields of research, in fact, there is no path at all; every one must blaze out his own trail.

Very few people have sufficient initiative to acquire this ability unaided, or even by the aid of books. The living instructor is usually essential. A certain body of traditional lore is passed on from generation to generation of thinkers and is never reduced to writing. One needs to draw from this source of inspiration. To acquire the power of research one needs to get close to some one who has it, to surprise him in the act of creative thinking and to learn his ways of working. No one is more pleased at this than the thinker himself, for he realizes how hard it is to transmit to others his acquisition, and yet he knows that this is the most important service which he can render. To transmit to others that elusive thing called point of view is at the same time the most important and the most difficult work of the instructor.

I have said that few individuals have sufficient initiative to acquire independently the power of research. On the other hand, I believe that there are many who may develop into successful workers if they come into intimate relations with a gifted instructor. The extraordinary success of students trained under such a man as Agassiz, for instance, is sufficient proof of this. He kindled a fire of enthusiasm which never burned out.

But why should one wish to acquire this power? The labor involved in its exercise is arduous. The material rewards are not great. The majority of one's contemporaries will not realize the importance of his work. In a little circle only, the inner circle of one's colleagues, will the labor be adequately appreciated. Therefore it is clear that whatever encouragement one has in undertaking such work must be of the higher sort, it must be ideal in its nature. To help you to see the true reasons for doing research is the principal purpose of this discourse.

First of all, what is the meaning of research to the individual who does it? What selfish end may he expect apart from the pleasure of service to his fellows? To do effective research is to know the spirit of mastery, the spirit of mastery where no one else suffers the pang of defeat. It is to develop the sense of superiority of mind over that which is not mind. It is consciously to obey the command to subdue the earth. It is to replenish it with a new creation. It is to make the universe a little fuller and richer by understanding it better.

But more than all this to the individual: he learns what it is to grow. Knowledge obtained otherwise is a sort of accumulation adhering to one outwardly; but when it is attained by independent research it is more like an integral part of one—not merely a possession, but an element of his very being. What I am saying will be made clearer by means of an illustration. A magnet attracts to itself iron filings and holds them indefinitely if they are not forcibly torn away; but however long they are kept in position, they do not become part of the magnet. The knowledge which is gotten by the usual means of acquisition is like these filings; it adheres to one externally. On the other hand, that which is discovered

through research is like the material which a plant takes up into itself in the process of growth; it becomes a part of one's essential being. Thus the work of research furnishes a means of self-development which is to be had in no other way. From this point of view to do such work will be a special privilege to one in proportion as he considers his individual development a matter of importance.

There is also a further advantage. When one has learned what it is to see a thing in the flood of light which research throws upon it, all knowledge begins to take a new appearance. The light of research reaches beyond the field in which it was kindled and illuminates the neighboring territory, and finally one's whole body of exact information. It puts one in a new world even while he is amid his old surroundings.

Let us next inquire, What is the meaning of research to the university? The way in which the reputation of the university, and consequently its power of service, depend on the character and amount of research done by its staff and graduate body is sufficiently objective to be in no danger of escaping your attention; and therefore I shall pass over this matter without further remark. But there is another thing more intimate, more subjective in its nature and more important in its influence, which, by its very closeness to your experience, may fail of appropriate recognition on your part. I refer to the atmosphere, in the academic community, which in large measure is created by your presence and work. This has a pervasive influence of a peculiar kind, and every environment which feels it is vitally affected by it. Every department of the institution is indebted to it for new tone and fresh vigor. A breath of life is infused into the undergraduate work and an inspiration otherwise unknown is felt. An institution in which pure research is regularly done has an atmosphere of its own which provides a training, even for the undergraduate who is not doing research, which can be secured in no other way. Through its students it contributes to the community at large a vital influence of far-reaching power.

It is obvious that a power of this kind may be utilized with different degrees of effectiveness. I believe that it often lies in part dormant, through the failure of graduate students to develop an appropriate *esprit de corps*. The great value to each individual of the spirit which pervades the undergraduate body is well known to all of you. A similar advantage may well accrue from the *esprit de corps* of an organized body of graduate students; and such a club as the present one is effective in contributing to this end. The wide divergence of interests in the various departments makes it harder to find common grounds of association than in the undergraduate work; but the advantages to be obtained are well worth an effort.

Again, let us ask, What is the meaning of research to the larger community of which the university forms a part? What immediate practical ends are attained? What more ideal and far-reaching results are accomplished?

It is one of the paradoxes of human progress that certain practical ends are best served by work which is laid out independently of practical considerations. It is only when one develops truth for the sake of truth itself that one takes sufficient time to forge all the links in the complete chain of theory. If the attainment of a practical end is the purpose in view minor matters which appear irrelevant will be entirely ignored, for the sake of economy of time. But if one is interested primarily in the development of science, no considerations, however unimportant they appear, are left out of account. One's esthetic sense can be properly gratified only by an all-comprehensive investigation of his subject. Consequently the man of research looks at his subject from all points of view and develops a complete theory simply for the sake of his delight in its beauty. When he has finished, it is often found that his discoveries are unexpectedly of great practical importance, sometimes directly and sometimes indirectly. Human progress owes a boundless debt to such agency.

Every science affords examples of the prac-

tical value of research to the community at large; but I shall not take time to enumerate any of these.

The chief value of science does not consist in the concrete advantages upon which we can readily lay our hands. All the beautiful results of an ideal nature which are accomplished for the individual researcher also accrue in a greater or less measure to the community at large. A new sense of mastery and adequate grasp of things pervades the general mind when the people realize that the thought of their generation is being developed in part by the men who go in and out before them. There is a feeling as of access to the inner circle of thought which is vivifying in its influence, when we know that those with whom we are associated are of the company of truth discoverers. There is a new tone to the community, and a fresh impetus to its study of the wider problems. Can any community remain the same when it receives a Newton, a Poincaré, a James, a vital man of research in any field?

This is a partial statement of the significance of research to the contemporary generation. But its influence reaches beyond the investigator's community or the political unit to which he belongs. It overflows into the whole world of thought, and thus contributes with great effectiveness to a modern movement which by many is believed to mark the beginning of a new era in human history. I refer to the widespread and universal feeling of brotherhood in man, a feeling of common sympathies and common interests which know no geographical or political or racial boundaries. The spirit of research, by its complete independence of everything which separates man from man, binds together elements of the most diverse origin into a common brotherhood in which all feel the same thrill of discovery, the same consecration to the task of extending knowledge, the same incentive to labor for human progress. It is the organizations of men of research which have the most effective international congresses; and the spirit which pervades these meetings is delightful. May we not see in this a forerunner of that day when all men will recognize the extent of their common interests, however diverse the outward forms of their life or their physical surroundings?

Whatever is of present advantage reaches out also to the future; and consequently everything which we have said so far may be applied in partial answer to the question, What is the meaning of research to the future of the human race? But such an answer is indeed partial; there are yet other essential things to add before it is made complete.

If we seek to look into the future we can succeed only by the light which is afforded by the past. Therefore let us examine briefly certain typical instances illustrating the way in which the research of one period has had its full fruition only in succeeding generations. You will pardon me if I draw these principally from the field with which I am best acquainted.

In the great days of ancient Greece her mathematicians were deeply interested in the study of the various curves which may be obtained as the intersections of a circular cone and a plane; and they developed many of the properties which belong to them, especially those of a metric nature. The incentive to this study was the esthetic delight in the body of doctrine itself; no important practical applications of their results were found—none was sought. For many generations this Greek theory of conic sections was transmitted without essential modification and without application to practical matters. Finally, through his acquaintance with this theory, Kepler was led to observe that planetary paths are a special kind of conic section; and his famous three laws of astronomy were discovered and made known. After a further lapse of time, Newton's meditations on Kepler's laws led to his formulation of the theory of gravitation, with the fundamental law of inverse squares as the basis. This in turn furnished the necessary foundation for celestial mechanics, and this magnificent structure was reared by several workers, notable among

them being Laplace. If we follow this chain further we shall find that celestial mechanics became the model for an exact science of any class of natural phenomena; and men sought to fashion the whole of mathematical physics after the same plan. It would be hard to overestimate the influence exerted in this way on modern science with all the practical consequences which it has introduced. It is fair to say that we are now reaping some of the practical benefits of the old Greek theory of conic sections, since this theory furnishes one of the essential tools by means of which our present body of science has actually been developed.

Let us take from Greek mathematics another example which illustrates the way in which the value of research is cumulative. Consider Euclid's geometry. It contains an ideal body of doctrine whose form is evidently determined by the author's delight in logical consistency and coherence. It is even yet a model according to which one fashions a careful logical exposition. As is well known, the ordered sequence of its propositions was the guide of the English philosopher Hobbes in constructing his body of philosophical doctrine.

A more recent and totally different kind of example of the value of research is afforded by Mendel's theory of inheritance. About fifty years ago Mendel was engaged in ascertaining the effect produced in various characters by crossing two varieties of peas; for the explanation of the facts which he gathered he offered a theory of inheritance which has since had a remarkable influence on biological thought. And now it appears as if results of profound importance to human progress will arise from the increased knowledge of heredity which Mendel's laws afford.

Examples of this kind might be multiplied indefinitely. The way in which practical consequences of great value have come unexpectedly from research in the past reminds us indeed that specific prediction is useless. When we notice the marvelous rapidity with which scientific facts are now gathered and compare this with the experience of the past, when we see the present magnificent consequences from the relatively meager material for work in the older time, we feel like asking, What is to be the future of research? To what grandeur will it attain? What blessing will it not bring to the human race? One does not dare to assign a limit to its possibility. How far short of the present marvels of science would have been the boldest predictions of the fathers of a hundred years ago!

A work which in the past has proved itself of so profound importance deserves adequate support in the present. Whence is such support to be derived? I wish to answer this question by saying that every unit in the world community should contribute to it. The state of Indiana should sustain her proper share of men of research, and for the further reasons which I am about to state.

That community in which research of the best quality and greatest amount is done will profit most by the total research of the world. Of course those communities which contribute nothing will in the end receive great benefit also. It will be later in coming to them and it will not manifest that vitality which characterizes it in more favored places; but it will come. A sense of fair play and a wish to profit to the fullest extent require, however, that each state shall properly support research in its own borders. Otherwise it becomes a sort of leech drawing its sustenance in part at the expense of the world at large. And no patriotic citizen can ever consent that his state shall be a pensioner on the bounty of others; it must do its part in the work of general progress.

R. D. Carmichael

Indiana University

THE TENTH INTERNATIONAL GEOGRAPHICAL CONGRESS

Under the sunniest of Italian skies the tenth International Geographical Congress was convened on the morning of the twenty-seventh of March in the historic Aula of the palace of the Campidoglio in Rome. His Majesty,

Victor Emmanuel, honored the occasion with his presence, and brief speeches of welcome were made by the mayor of the city, by Marquis Capelli, the president of the congress, and by the Italian Minister of Public Instruction, to which welcome Professor Otto Nordenskiöld, of Sweden, responded on behalf of the delegates present.

Seldom has so attractive a program of papers been prepared as that which was mailed to geographers throughout the world; but, alas, two successive postponements together amounting to nearly two years, might well be thought sufficient to dampen the enthusiasm alike of committee and prospective guests. It is, therefore, a pleasure to be able to state that in the face of these discouraging conditions the congress was a distinct success; though probably less than it would have been had not the committee decided to adhere strictly to the original program of papers by absentees and refuse all papers offered later than October, 1912.

A partial list of well-known geographers who were in attendance includes: Bruce, Brückner, Chaix, Chisholm, v. Cholnoky, Close, Cvijic, Déchy, Gallois, Hamberg, Helland, Kövesligethy, Lescointes, Loczy, de Margerie, Nordenskiöld, Oberhummer, Peary, Passarge, Penck, Pumpelly, de Quervain, Schott, Schokalsky, Sapper, Stefanssen, Supan, Teleky, Vidal de la Blanche, Wagner and Woeikof.

Geographers of all nations vied with each other in showing honor to Admiral Peary, the discoverer of the North Pole, who represented at the congress both the Association of American Geographers and the Peary Arctic Club. The only other Americans in attendance were Vilhjálmur Stéfanssen, the explorer, who represented the American Museum of Natural History, Professor Raphael Pumpelly, Mr. H. L. Bridgeman, representing the American Geographical Society and the Geographical Society of Philadelphia, and the undersigned, as delegate of the American Philosophical Society and the University of Michigan.

As might have been expected, the congress was less notable for important papers presented than by reason of programs decided upon for international cooperation. Dr. de Quervain presented, however, a preliminary report upon his crossing of Greenland in 1912, and exhibited for the first time his final map of the route and his section across the continent. Professor Emile Chaix, on behalf of the executive committee of the commission on a collection of views to illustrate the terrestrial relief, made a most attractive presentation of the work already accomplished. Mr. Stéfanssen described the geographical features of the country traversed on his recent expedition to Arctic America, and outlined briefly his plans for an expedition to Coronation Gulf soon to be undertaken by him for the Canadian government. Captain W. S. Bruce, after giving an account of his Antarctic expedition in the *Scotia,* outlined a projected expedition which will have for its object the direct crossing of the Antarctic continent from the Weddell Sea to McMurdo Sound by way of the South Pole and the inland ice plateau to the west of the mountain ranges in Victoria Land. Professor Kövesligethy, of Budapest, described his method for the prevision of earthquakes based upon the analytical expression of the hysteresis of the earth's outer shell, with data supplied from the velocity of wave propagation. Professor Gaetano Platania described the latest eruption of Mt. Etna with quite remarkable lantern slides from photographs taken by Mr. Frank A. Perret, the American vulcanologist.

At the request of the International Commission for the preparation of the "millionth" map of the world, it was decided to hold another official conference, which will be convened in Paris before the close of the present year, to which all civilized nations will be invited to send delegates. For the present the office of the Ordnance Survey in London is to remain the official center of the enterprise, to which therefore all correspondence should be addressed. The congress approved a proposition to prepare a "Universal Geography" to accompany the millionth map, but

no plans were formulated for so pretentious an undertaking. Based upon this world map, it is proposed also to prepare an international aeronautical map of the world on scale of 1:200,000, and an official conference to determine the details is to be convened.

The delegates voted in approval of the proposition that the most important problems to be settled in connection with the international exploration of the north Atlantic Ocean relate to the size, the regional extent and the nature of periodic variations of water layers to the depth of 1,000 meters, and it was recommended to continue systematic observations upon ocean currents and upon the temperature and salinity near the surface of the sea.

The proposition of the Danish Geographical Society was approved to invite the geographical societies of Rome, Madrid, Lisbon, Geneva, London, Berlin, Vienna, New York, Paris, St. Petersburg, Copenhagen, Brussels, Amsterdam, Christiania, Stockholm and Budapest to meet in Denmark in 1914 for the purpose of organizing a World Union of Geographical Societies. A large committee was appointed with one or more members from each country possessing ancient maps of its domain, for the *refection* of these maps, these gentlemen being charged with the preparation of a catalogue to be printed in a geographical journal before the opening of the next congress. Dr. E. L. Stevenson, of the Hispano-American Society of New York, was made the representative for Spain.

Much enthusiasm was shown in approving a proposition to organize in each country during the summer vacation periods of the higher institutions of learning, international courses of instruction in geography, in which foreign savants would be invited to take part. The plan contemplates also the founding of an International Geographical Institute, the seat of which is left for later determination, this institute to direct and coordinate the studies and all geographical initiatives which have an international character.

The difficult questions concerned with the confusing duplicate place names on international frontiers (such, for example, as the Alps and Pyrenees) it was voted to refer to a commission with a view to securing the general use in each case of a single term, or, when this seems impracticable, terms which are in correspondence. After a warm discussion the proposal to add Spanish to the four official languages of the congress was definitely and decisively rejected. The eleventh international congress it was decided to hold in St. Petersburg in 1916, with a rather general understanding that the next succeeding congress would be convened in Vienna.

The social events included a reception at the palace of the Campidoglio and a complimentary dinner tendered to the delegates by the committee of organization. Delightful local excursions were made to Tivoli, Ostia, Terni and the Alban Hills; and after adjournment there were longer journeys to the Po Valley and Préalpes on the one hand, and upon the other to Naples (Mt. Vesuvius and the *Campi Phlegræii*), Sicily (ascent of Mt. Etna) and Tripoli.

The weather throughout the meeting was perfect and the campagna at its best in its spring garlands of flowers; but it may be questioned whether Rome is not, even without these allurements, too interesting in itself to be an ideal seat for international congresses.

Wm. Herbert Hobbs

April 15, 1913

SCIENTIFIC NOTES AND NEWS

Professor J. M. Aldrich, the circumstances of whose enforced retirement from the professorship of zoology and entomology at the University of Idaho, are described by Professor Vernon L. Kellogg in this issue of Science, has accepted a position in the Bureau of Entomology, U. S. Department of Agriculture.

The American Geographical Society has conferred its Charles P. Daly gold medal upon Dr. Alfred H. Brooks for his geological and geographical work in Alaska.

The Georg Neumayer gold medal was bestowed upon Dr. L. A. Bauer, director of the Department of Terrestrial Magnetism of the

Carnegie Institution of Washington, on May 3, in connection with the celebration of the eighty-fifth anniversary of the Berlin Gesellschaft für Erdkunde. The medal is awarded to Dr. Bauer for his researches in terrestrial magnetism. Professor Neumayer, who founded the medal, will be recalled as the most eminent student, during his lifetime, of the earth's magnetic phenomena. The medal has not been awarded since 1906.

Dr. George H. Barton, director of the Teachers School of Science, Boston, was given a dinner and a presentation on May 9. Among those who made addresses were President Maclaurin, Professor Sedgwick and Professor Burton, of the Massachusetts Institute of Technology; Professor Woodworth and Professor Ropes, of Harvard University; Professor Fisher, of Wellesley College, and Professor Lane, of Tufts College.

Dr. Rossiter W. Raymond, of Brooklyn, was elected an honorary member of Alpha Chapter of Tau Beta Pi at a joint meeting of Tau Beta Pi and Phi Beta Kappa, at Lehigh University last week.

Sir David Gill, formerly astronomer at the Cape of Good Hope, has received the insignia of commander of the Legion of Honor, which has been conferred on him by the president of the French Republic.

The council of the Institution of Civil Engineers has made the following awards for papers read during the session 1912–13: A Telford gold medal to Mr. Murdoch Macdonald, C.M.G. (Cairo); a George Stephenson gold medal to Mr. G. D. Snyder (New York); a Watt gold medal to Mr. H. A. Humphrey (London); Telford premiums to Messrs. C. W. Methven (Durban), B. Hall Blyth, Jr. (Edinburgh), C. J. Crofts (Durban), Frank Grove (Canton), B. T. B. Boothby (Hankow), and Francis Carnegie (Enfield Lock), and the Manby premium to Capt. C. E. P. Sankey, R.E. (London).

President Wilson received on May 6 a committee of the American Medical Association, which urged a general conference to discuss plans for a federal department of public health and matters pertaining to the conservation of human life and efficiency. Professor Irving Fisher, of Yale; Dr. John B. Murphy, of Chicago; Dr. G. H. Simmons, of Chicago; Dr. L. K. Frankle, and Dr. Abram Jacobi, of New York; Dr. Harvey M. Wiley, Senator Owen, and Representatives Foster, of Illinois, and Curley, of Massachusetts, were present.

Dr. Paul Marchal, chief of the Entomological Station of Paris, professor in the Agronomical Institute of France, and a member of the French Academy of Sciences, landed in New York on the fourth of the present month. He comes to America for the purpose of studying the organization of the Bureau of Entomology of the Department of Agriculture at Washington and other organizations working in applied entomology. He will remain in the United States for two or three months. Dr. Marchal is especially well known to general students of biology and morphology on account of his remarkable researches in polyembryony. In the course of his stay he will visit most parts of the United States.

Dr. Peer Geijer, the Swedish geologist, has joined the University of Wisconsin expedition to the Lake Superior mine regions. The party consists of advanced students in the engineering college and professors. The inspection tour is made every two years. Besides Dr. Geijer, J. J. O'Neill, of the Canadian Geological Survey, and G. W. Crane, of the Missouri State Geological Survey, are of the party.

Professor W. J. Baumgartner, of Lawrence, Kansas, will conduct his fourth party of biologists to the Puget Sound Marine Station at Friday Harbor, Wash., this summer. A chartered car will leave St. Paul on the morning of June 14, and will go over the beautiful Canadian Pacific route, stopping to visit glaciers, etc. Six weeks will be spent on the coast studying the exceedingly rich fauna and flora under very favorable conditions.

Professor Henry H. Norris, head of the department of electrical engineering at Cornell University, has resigned to join the editorial boards of *The Electric Railway Journal* and *The Electric World*, of which he has been an associate managing editor for some years.

Among those who spoke at the dedication of the engineering buildings on May 8 and 9, at the University of Illinois, were Mr. Samuel Insull, president of the Commonwealth Edison Company; M. J. G. Panghorn, special representative of the Baltimore and Ohio Railroad; Mr. John Hays Hammond, mining engineer, American Institute of Mining Engineers; Mr. W. L. Park, vice-president Illinois Central Railroad; Mr. Isham Randolph, consulting engineer, Chicago, and Governor Edward F. Dunne.

Mrs. Christine Ladd Franklin, of New York City, gave last week at Columbia University and is giving this week at Harvard University three lectures on "Color Vision."

On April 7, Dr. Haven Metcalf, of the Bureau of Plant Industry, lectured at the University of Wisconsin on "The Work of the Government in Forest Pathology."

The Linacre lecture of Cambridge University was delivered by Dr. Norman Moore on May 6 in the lecture room of anatomy and physiology, New Museums. The title of the lecture was "The Physician in English History."

Sir J. Alfred Ewing gave a lecture on the structure of metals before the Durham Philosophical Society on May 2.

A committee has been formed, with the king of Italy as president, to establish suitable memorials of the late Professor Giovanni Schiaparelli, the distinguished astronomer.

The teachers of the Normal School at Avignon, of which M. J. H. Fabre, the entomologist, was a pupil, are taking steps to erect a monument in his honor. The council of Vaucluse has voted 1,500 francs to the fund.

Mr. Shinobu Hirota, who recently returned to Japan after assisting Professor Milne for eighteen years in his work in seismology, died on April 24.

The British government intends, as we learn from *Nature,* to ask parliament to sanction a special vote sufficient to provide as follows: For Lady Scott (in addition to the Admiralty pension of £200 per annum for herself and £25 per annum for her son, until he reaches the age of eighteen) an annuity of £100. For Mrs. Scott, the mother, and Mrs. Campbell and Miss Grace Scott, the sisters, of Captain Scott, a joint annuity of £300. For Mrs. Wilson, the widow, and Miss Mary Souper, the sister-in-law, of Dr. E. A. Wilson, a joint annuity of £300. For Mrs. Evans, the widow of Petty Officer E. Evans (in addition to the pension and allowances awarded to her by the Admiralty, amounting to 13s. 6d. a week), a further annuity of 12s. 6d. a week for herself and 3s. a week in respect of each of her children up to the age of eighteen. The government of India, in the service of which Lieutenant Bowers was before joining the expedition, has offered to provide pensions, amounting in all to £100 per annum, for his mother and sisters. Captain Oates, the fifth member of Captain Scott's southern party, was unmarried; and as no mention is made of any relatives, it may be assumed that he was possessed of ample means. In addition to the provision referred to, the total amount subscribed by the public as a memorial for the dead explorers and kindred purposes is £55,760.

The surgeon general of the army announces that preliminary examinations for appointment of first lieutenants in the army medical corps will be held on July 14, 1913, at points to be hereafter designated. Full information concerning these examinations can be procured upon application to the "Surgeon General, U. S. Army, Washington, D. C." The essential requirements to secure an invitation are that the applicant shall be a citizen of the United States, shall be between 22 and 30 years of age, a graduate of a medical school legally authorized to confer the degree of doctor of medicine, shall be of good moral character and habits, and shall have had at least one year's hospital training as an interne, after graduation. The examinations will be held simultaneously throughout the country at points where boards can be convened. Due consideration will be given to localities from which applications are received, in order to lessen the traveling expenses of applicants as much as possible. In order to perfect all necessary arrangements for the examination,

applications must be completed and in possession of the adjutant general at least three weeks before the date of examination. Early attention is therefore enjoined upon all intending applicants. There are at present forty vacancies in the medical corps of the army.

The International Association of Medical Psychology and Psychotherapy will hold its annual meeting at Vienna on September 18 and 19, immediately before the opening of the Congress of German Men of Science and Physicians.

Mining students of the University of Illinois will hold a mining exhibit in connection with the dedication of the Mining Laboratory on May 8, 9 and 10. This will consist of a display and demonstration of the heavy mining machinery and apparatus of the new building.

Through the cooperation of the Bermuda Natural History Society and Harvard University, the Bermuda Biological Station for Research will be open this summer as usual for about six weeks, from the middle of June till August. Botanists or zoologists wishing to avail themselves of this opportunity should communicate with Dr. E. L. Mark, 109 Irving St., Cambridge, Mass.

During the months of July and August the facilities of the Seed Laboratory of the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C., will be available as far as space permits to any one who wishes to consult the seed collection and become familiar with the practical methods of seed testing for mechanical purity and germination. For further information address Mr. E. Brown, botanist in charge.

Secretary Daniels has withdrawn the offer of warships for the use of college students because of the new plans for the Atlantic fleet. Sending the fleet through the Mediterranean will make it necessary to use some of the ships, now in reserve, for various details. Consequently there will be none left that will be available for the use of college men.

At the recent annual meeting of the Naples Table Association for Promoting Laboratory Research by Women, the use of the table supported by the association at the Zoological Station at Naples was granted for the coming year to Dr. Rhoda Erdmann, of Berlin, Germany, and Dr. Caroline Thompson, professor of botany at Wellesley College. The Ellen Richards research prize of $1,000 for the best thesis written by a woman on a scientific subject embodying new observations and new conclusions based on independent laboratory research in biological, chemical or physical science, was awarded to Miss Ida Smedley, London, England, D.Sc., London University, who has been working for the past four years in the biochemical laboratory of the Lister Institute of Preventive Medicine. The subject of the winning thesis was: "An Investigation into the Methods of Formation of Fatty Acids from Carbohydrates in the Organism." Ten theses were submitted in competition. The examiners for the award of this prize were: Dr. W. H. Howell, Johns Hopkins Medical School; Dr. Theodore Richards, of Harvard University, and Dr. Henry Crew, of Northwestern University. The following officers were elected:

President, 1913–14—Miss Ellen F. Pendleton, president of Wellesley College.

Treasurer, 1913–14—Mrs. Elizabeth L. Clarke, a trustee of Smith College.

Secretary, 1913–16—Mrs. Ada Wing Mead, of Providence.

The Utah Eugenics Society met on April 3, for permanent organization, having existed under temporary organization since May 20, 1912. The committee on permanent organization reported constitution, by-laws, and recommendations to the meeting and nominations for officers. After a short program, consisting of talks on various phases of eugenics by Mr. Mathohniah Thomas, Professor E. C. Gibbs, of Salt Lake High School, Mrs. Martha C. Jennings, matron of women, Salt Lake City High School, Dr. E. D. Ball, of the Agricultural College, the following officers were elected:

President—Mathohniah Thomas, Salt Lake City.

First Vice-president—J. C. Wheelon, Garland.

Second Vice-president—Dr. Fred Taylor, Provo.

Secretary and Treasurer—Dr. E. G. Titus, Logan.

Members of the Council—Mrs. Martha C. Jennings; Professor Jacob Bolin, Salt Lake City; Dr. E. G. Gowans, Ogden.

IT is stated in foreign journals that the scheme for a canal to open through communication between the Black Sea and Baltic by linking the systems of the Dneiper and Duna seems now in a way to be realized. It is said that the necessary capital of 450 million roubles will be supplied by a foreign country, and that official permission for the commencement of operations will at once be given. Great hopes are entertained of the commercial development likely to ensue from the making of the canal, which will open up an important route for the export not only of Russian corn, but of timber, ores, petroleum, etc., as well as for the import of coal. It is pointed out that the railway freight across Russia is at present some 20 kopeks per pood, to which some 4 or 5 kopeks must be added as sea-freight to Hamburg or England; that the southern sea-route from Odessa involves a freight of 7 or 8 kopeks, with an additional sum of anything up to 6 kopeks for railway transport to Odessa; whereas the freight from Kherson to Riga is reckoned at only 3 to 5 kopeks per pood by the canal now to be constructed. Another important scheme lately put forward is for a canal to open communication between Central Russia and Siberia by linking the systems of the Volga and Obi-Irtish. The proposed route would make use of the Chusov and a tributary, on the west of the water-parting; and the Reshotka, Isset and Tobol on the east, thus entering the Irtish close to Tobolsk. The length is 1,100 miles, and the waterway is designed to take vessels of 5½ feet draught and a length of 350 feet. The general question of the development of Siberian waterways will shortly, it is said, be investigated on the spot by a commission of engineers.

ACCORDING to *The British Medical Journal* an institute for Medical Research in South Africa is being established at Johannesburg on the southern portion of the ground lying to the west of the general hospital and to the south of the fort. There has hitherto been no medical research institute in South Africa. A veterinary institute was erected and equipped by the government some time ago at Dasbort, eight miles from Pretoria, but though the need for a medical research institute has been pressed by members of the medical profession, financial objections have prevented any forward movement. Recently, however, the government and the leaders of the mining industry collaborated, with the result that generosity on both sides has provided not alone for the building and equipment, but also its maintenance. The new institute at Johannesburg is to serve the whole of South Africa and will be called the South African Institute for Medical Research. The industrial diseases of the Transvaal will probably first call for consideration, owing to the mortality which they have occasioned, but the work will not be limited to these diseases, and it is hoped to attract skilled workers from Europe to aid the director in his researches; it is probable that research fellowships will be available for suitably qualified medical men desirous to carry out special lines of research. The proximity of the institute to the general hospital, which is the largest in South Africa, and the fact that it will be equipped with four wards, with twenty or thirty beds for the treatment of patients, will serve to associate the institute with medical work in Johannesburg. When the institute is in full working order it is probable that courses in bacteriology and pathology will be arranged for medical students. Two appointments have already been made to the staff. The director of the institute is Dr. Watkins-Pitchford, and the statistician, Dr. G. D. Maynard. Dr. Watkins-Pitchford was formerly house-physician to St. Thomas's Hospital, London; he studied plague in India, enteric fever in South Africa during the war, smallpox in London. For the last ten years he has been government pathologist and analyst for Natal, and last year was transferred by the union government to

Johannesburg. Dr. Maynard was formerly M.O.H. for the suburbs of Pretoria, and subsequently assistant medical officer to the Witwatersrand Association. It is expected that the building will be completed in about a year.

THE British secretary of state for the colonies has, as we learn from *Nature,* appointed a commission to study the nature and the relative frequency of the fevers occurring amongst the Europeans, natives and others in West Africa, especially with regard to yellow fever and its minor manifestations.

M. JULES DE PAYER, as we learn from foreign exchanges, has furnished particulars of his projected Arctic expedition, which is intended to leave France in the summer. With the support of the government and various societies, he will follow his father, the distinguished explorer, in making for Franz Josef Land. One of his objects is to locate the margin of the polar basin to the northeast of that archipelago, an investigation which, if successfully carried out, will provide data for an estimate of the relative areas of the basin and the continental shelf in that quarter of the Arctic region. A scientific staff will accompany M. de Payer, with equipment for the prosecution of research in all the various departments which have become associated with polar work; among them the investigation of the upper atmosphere by means of kites is specially indicated. The party will be provided for a sojourn of one year or longer in the north, its ship returning in the meantime. It is to be provided with two aeroplanes, the utility of which as instruments in polar research will be observed with interest: a visit to the pole itself is mentioned as a possibility, but does not appear as a prime object of the expedition. Wireless telegraphy will be installed at the headquarters.

THE Washington Academy of Sciences has held a field meeting including the region of Cape Henry and Yorktown, which left Washington by a special steamer on April 25 and returned on April 27.

THE regular monthly meeting of the State Microscopical Society of Illinois was held on April 10, 1913, at the rooms of the Chicago Press Club. The subject for the evening was "Bacteria, with Practical Demonstration in preparing Slides and Cultures," by Margaret Grant, A.M., M.D. At this meeting final reports of the recent soiree by the society and the Academy of Sciences, held in the academy building, Lincoln Park, were submitted, showing that there were twelve hundred persons in attendance. Sixty-one microscopes were in charge of forty-eight exhibitors.

UNIVERSITY AND EDUCATIONAL NEWS

THE board of regents of the University of Nebraska, at its annual meeting, voted a general increase in salaries of deans and professors, distributing thus the $35,000 additional maintenance voted by the last legislature.

THE faculty of the Ohio State University has adopted an arts-agricultural course, five years in length. The first three years, students will be registered in the Arts College; the last two years, in the Agricultural College. At the end of the fourth year, the degree of bachelor of arts will be given, and at the end of the fifth year, the bachelor of science in agriculture.

THE Phi Beta Kappa elections for the year at the University of Wisconsin indicate that women students excel men in scholarship, as twenty-two of the thirty-six elections were women.

PROFESSOR OSKAR BOLZA, of the University of Freiburg, is to offer courses this summer at the University of Chicago on "Linear Integral Equations" and "Functions of a Complex Variable." Other graduate courses in mathematics are announced on "Fourier Series," "Linear Continuum and Point-set Theory" (Moore); "Projective Geometry" (Bliss), and "Modern Theory of Analytic Differential Equations" (Moulton). Dr. F. A. Lindemann, of the University of Berlin, is to lecture throughout the summer quarter at the University of Chicago on "Kinetic The-

ories." Other graduate lecture courses in physics are announced on "Relativity" (Lunn), "Wireless Waves" (Kinsley), "Radiation Theories" (Millikan).

DR. FRANKLIN D. BARKER has completed ten years of service in the University of Nebraska and has been made a full professor, having charge of the work in medical zoology and parasitology in the department of zoology.

DR. IRA D. CARDIFF, professor of plant physiology and bacteriology in Washington State College, has been appointed head of the department of botany. Professor John G. Hall, of the South Carolina Agricultural College, has been appointed professor of plant pathology in the same institution.

To the professorship of bacteriology in Columbia University made vacant by the death of Dr. Philip Hanson Hiss, Dr. Hans Zinsser, professor of bacteriology in Leland Stanford University, has been appointed.

DISCUSSION AND CORRESPONDENCE

UNIVERSITY LIFE IN IDAHO

TO THE EDITOR OF SCIENCE: Professor J. M. Aldrich, professor of zoology and entomology in the University of Idaho (Moscow), has just been summarily dismissed without trial or official warning after twenty years of faithful and successful service. The conspicuous incidents connected with this matter are few, simple and suggestive. They are the following:

In 1900 James A. McLean, a young Canadian, came to the University as president and director of the agricultural experiment station. He was a doctor of philosophy from Columbia in economics. He found the duties of director of an agricultural experiment station bewildering and uncongenial.

In 1904 Professor Aldrich with five other members of the faculty protested to the board of regents that the president was incompetent for his place. Strangely neither the president nor the protesting professors were dismissed but a compromise was effected which endured for eight years. It may be inferred from later occurrences that despite the long and healing lapse of time, the criticized president did not forget nor forgive his critics.

In 1912 President McLean left Idaho to become the president of the University of Manitoba. Before he left he made out, and gave to the board of regents, a list of professors who ought to be dismissed.

Near the end of 1912, Idaho did away with all separate boards for its various educational institutions and put its whole system in charge of a single new board. The law enacting this provided that the old boards shall hold their last meetings in the following spring.

In April, 1913, President McLean, of the University of Manitoba, crossed an international boundary and the boundary of decency and in secret session with the acting president of the University of Idaho made up a list of seven undesirable professors which list was presented to the dying board of regents and promptly acted on. All were dismissed. At the end of the meeting the board died, and its victims received their malodorous notices of dismissal two days after the board had been defunct. Thus Professor Aldrich and six colleagues have enjoyed the peculiar experience of being removed from their positions on the recommendation of a citizen of Manitoba by an official board which passed out of existence before the victims knew what had happened to them.

An appeal to Governor Haines of Idaho has resulted in an official statement that the regents acted entirely within their authority.

No comment seems necessary on these interesting incidents. Professor Aldrich, who is an unusually competent entomologist, and a peculiarly prepossessing and attractive man, will of course have no difficulty in finding work elsewhere. Will Idaho have as little difficulty in getting as good a man to fill his place?

VERNON L. KELLOGG
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EDUCATIONAL STANDARDS AT AN AGRICULTURAL COLLEGE

PERFECT freedom in the expression of ideas and opinions is born of one of two conditions, either full information, or lack of informa-

tion. Any other condition suggests the advisability of caution. Dr. Pritchett in his letter to the Iowa Board of Education speaks with a freedom and confidence suggesting the most intimate acquaintance possible with the ideals, the strength and the attainments of colleges of agriculture. The prescription which he gives appears within itself to follow the most searching and conclusive diagnosis.

Dr. Pritchett's diagnosis consists of two main parts: first, agricultural education, at least for Iowa, should be of a trade school standard and type; and second, agricultural education must be isolated from other lines, particularly from engineering.

Regarding the first of these specifications Dr. Pritchett says:

> The school of agriculture ought to teach preeminently the trade of farming, even though it does research in its experimental station, and conducts certain classes of high order, its primary function ought to be not the training of agricultural teachers, but the training of farmers, and the cultivation of the means by which the scientific knowledge in a practical form can be put into the hands of farmers. The great part of the work is not on a professional plane. Students of agriculture ought not to be required to comply with the same academic standards as those who expect to enter the profession of engineering. . . . In my judgment the interests of agriculture will be subserved by making the agricultural college a straight-out school of agriculture, with entrance requirements suited to the needs of those who wish to become practical farmers. I should not make these academic requirements for admission higher than the equipment afforded by the elementary schools.

This at least has the merit of being explicit. Dr. Pritchett would take the boy at the same stage of development required for entrance into the freshman year of the high school, and after getting him into this so-called college would teach him how to farm. The objections to this academic program are many, but possibly an illustration may serve the purpose. A man concerned in educational matters in Tennessee had been converted to the agricultural point of view. He made no such mistake as to go to the people with messages of chemistry, botany or zoology, but on the contrary advocated eminently practical measures. At a meeting up in the hill country he made an address in which he labored long and arduously to prove to the audience that every boy, and every girl, should know how to milk a cow, and to this end should attend an agricultural college. After wearing himself and the audience pretty well out he threw the meeting open for remarks and discussion. After a painful silence, a gaunt old man with hay-colored whiskers, the principal of a theological seminary, arose. "Stranger," said he, "I agree with you that every boy, black or white, should know how to milk a cow. I even agree that every girl should include this art along with her other accomplishments. However, I want to make this suggestion: Wouldn't it be a good thing for a college to teach its students something that a calf couldn't beat 'em at?"

If the farmers send their sons to the agricultural college in order that they may learn how to farm there are going to be a lot of disappointed farmers. At Wheaton, Illinois, plowing matches are held each fall and men who never saw a college do plowing so nearly perfectly that only those experienced in the accomplishment are able to act as judges. This skill could be learned at college, no doubt, but why run a college for teaching an art which can be learned readily in connection with farming operations? The college could no doubt develop great proficiency in the art of husking corn, but it is doubtful whether it could out-do boys who never so much as finished the country school. There are hundreds of men in Iowa who can feed cattle so successfully that few colleges would care to compete with them in the results to be obtained as judged in dollars.

What the farmer should, and does, demand of the college is a solution of the problems which are too intricate for him to solve for himself. The farmer can put fat onto steers about as rapidly as can a college professor, but he can not analyze feeds. Neither can the farmer analyze his soils or identify the pests that infect his crops. Should the college

undertake to teach these things along with the practise of farming to a lad just out of the eighth grade? Manifestly not, and for the reason that to him that hath shall be given. Few of the well-prepared boys who enter college make good scientists. Almost none of those entering Dr. Pritchett's ideal school would be able to comprehend scientific problems at all. They would go back to the farms because unprepared for any of the more advanced lines of agricultural work.

Dr. Pritchett believes that the Iowa State College has turned out more lawyers than farmers. It is too bad to break down a system of beliefs by ruthlessly intruding the facts, but the information at hand shows that about two fifths of the recent graduates of the agricultural courses are engaged in actual farming, while only 5 to 7 per cent. are in non-agricultural work. But few of the graduates have become lawyers. Until the demand for teachers and experimentalists is met it is hard to comprehend where they are to be trained if not at agricultural colleges. It is also difficult to see how these men could be more useful to the state by working a farm than by teaching the sciences pertaining to farming, editing farm papers, or testing hypotheses concerning the application of science to agriculture. This answer must be either that all scientific research is now complete, or else that scientific research is not worth while, since, forsooth, the agricultural college should make its main work the teaching of the art of farming.

The second thing needful in realizing Dr. Pritchett's ideal in agricultural school effort is isolation. This needs no discussion, since the grade of education he has in mind certainly could not flourish in a college, alongside of, and on a par with, real college work. However, the world is big and there is a place for the grade of instruction which the doctor has in mind. In fact it is being offered in the numerous short courses at the college and over the state. There will be more such short courses in the future, but the college will hardly go out of business in order to make room for them. It is not improbable that county agricultural high schools, or even township schools may, in a way which the college could not, meet the needs which Dr. Pritchett has in mind. Something of the sort has been begun. In Europe this kind of instruction is common, but the agricultural colleges are not sacrificed in order that it may be done. On the contrary, they furnish the teachers and a large part of the subject matter for the courses given in the lower grade schools. A paragraph from Dean Bailey, of Cornell, often called a prophet in agriculture, will not be amiss:

> An internal danger is the giving of instruction in colleges of agriculture that is not founded on good preparation of the student or is not organized on a sound educational basis. Winter-course and special students may be admitted, and extension work must be done; but the first responsibility of a college of agriculture is to give a good educational course; it deals with education rather than with agriculture, and its success in the end will depend on the reputation it makes with school men.

B. H. HIBBARD

A CALL FOR AMPLE AND TRUSTWORTHY VITAL STATISTICS

THE appeal of Dr. J. Madison Taylor, published in SCIENCE, October 11, 1912, for a more general and critical body of human statistics is one which should elicit a ready response upon the part of scientific men generally. No one who has had occasion to investigate a problem involving data of human history but can confirm the deficiencies to which Dr. Taylor refers. Something over a year ago the present writer began an inquiry relating to educational betterment which led to a search of various documents such as yearbooks, census reports, reports of the Bureau of Education, etc., and it soon became apparent that these sources were noteworthy for what they did not contain. In other words, they were woefully lacking in just that class of data which were vital to the inquiry in hand. An inquiry as to the existence of personal and family records soon revealed the fact that here, even more than in the other sources, except in rare instances, it was almost impossible to discover data of any adequate or reliable character.

The importance of such data in their rela-

tion to various problems of human interest is too well known to call for argument. However, it may not be amiss to cite a few incidental phases of such interest, and among them the following are especially important. Maudsley long ago ("Pathology of Mind"), emphasized its importance in relation to questions of insanity.

When we are told that a man has become deranged from anxiety or grief, we have learned very little if we rest content with that. How does it happen that another man, subject to exactly similar causes of grief, does not go mad? It is certain that the entire causes can not be the same where the effects are so different; and what we want to have laid bare is the conspiracy of conditions, internal and external, by which a mental shock, inoperative in one case, has had such serious consequences in another. A complete biographical account of the individual, not neglecting the consideration of his hereditary antecedents, would alone suffice to set forth distinctly the causation of his insanity.

It is hardly necessary to say that what is stated in this case has become greatly more certain in the light of manifold facts of current knowledge.

But important as is such knowledge in its bearing upon insanity as a malady to be cared for or treated, it is even more important in its possible relations to social and economic problems. It is no part of the purpose of this brief paper to deal with these phases of the subject. The problem which has concerned the writer is that of eugenics in relation to educational betterment. With many who have been concerned in the present status and tendencies in educational progress he has had a growing conviction that conditions are deplorably bad in many respects, and in some matters the situation is grave to a degree not generally realized. It is not the ranting criticism of hasty reformers and radicals of quixotic type which is the occasion of concern. But those who know best the situation, those who are upon the inside, the friends of the best in educational tradition and inheritance, have been among the critics, and have not hesitated to cry aloud and spare not. Then, too, we have had opportunity to "see ourselves as others see us." Our system of education has been designated as a "*Proliferating Mediocrity.*" It is thrown into our teeth that the present generation has added little or naught to literary, or philosophic, or scientific greatness; that we take none of the Nobel prizes for scholarly achievement; that American schools are glorified chiefly as a *theoretical system.* To such arraignment we may, or may not plead guilty, according to our points of view. This is not the place to discuss the pros or cons. Conditions have provoked the challenge and criticism. It is serious enough to give us pause, and to awaken inquiry and analysis. Assuming there are possible grounds for criticism, that our so-called system is not perfect, that a tendency to mediocre results exists, what can be done in the matter? And further, what has all this to do with vital statistics?

Considering first the last feature, let it be noted that had there been gathered during the century past a body of school statistics of a critical and informing character we should be in possession of just the data which would enable us to answer some of these questions in a more thorough and convincing manner than is possible without them. It is very well to glorify the values of education by pointing to distinguished jurists, statesmen, educators and others, as products of Harvard or Yale or Oxford, etc., but it may still be open to query whether *all this is so!* The cynic will retort "They were great in spite of this, that or the other college!" And who has convincing evidence for or against?

But this is not the only, or chief, call for statistics. There has long been current, as a sort of creedal tenet, applicable to all sorts of social or civil or religious or educational conditions, the adage *all men are created free and equal!* But deductions of science and sociology have later been declaring the very opposite, that men are created under bondage and to inequality through laws of heredity and variable environment. So far as education is concerned it may be assumed as beyond reasonable debate that the armies of idiocy, imbecility, feeble-mindedness, to mention no

others, prove the latter conclusion all too convincingly.

But among the educable none who has had practical experience with the problem is likely to espouse the older tenet. Limitations and inequalities are obvious conditions, not for the schools alone, but for every vocation or avocation of human life. Now, in theory, all this has been quietly ignored. We have framed our curricula, whether of kindergarten, school or college, on the older assumption. There have been *radicals* at work on the curricula of schools for delinquents and imbeciles, and the latter view of human nature has been unhesitatingly accepted as settled. But not so in the schools for normal and subnormal children. Here we still adhere to the older assumption; and while the dunce-cap or the rod may have passed as an index of our inherent faith in our creed, still there are other evidences of the integrity of our creedal loyalty! And how has it worked out in practise? The answer, at least in part, is simple and obvious. Scholarly standards have been made to suit *averages.* While a large proportion are capable of successfully achieving the general average, a considerable proportion could just as easily attain the highest rank of efficiency. But first consideration has been given to the mediocre or average class. The pupil of fine ability, of potential genius, has been allowed to drift, to loaf after the easy task of the average has been met in an indifferent way! And what of the backward or low grade pupil? Here too has there been the same ill-directed mechanical ideals; he has been abused, hectored, discouraged and allowed to become a part of the flotsam of ne'er-do-wells.

Vital statistics comprising such data as Dr. Taylor suggests, among which are baby records of growth, development, physical and physiological peculiarities, etc., including also data of early childhood and its distinctive traits and idiosyncrasies, would furnish a first discriminative basis for educational outlook. Following this up with similar data of kindergarten and grade schools, in connection with such devices for testing mental quality as the Binet Scale, the intelligent teacher has at command a ready means for differentiating the school work so as to insure from it a degree of efficiency which in the past has been quite out of the question. Such school statistics, made a part of the permanent records of the school, are at once available, not only as they relate to school pedigrees, but might readily become part of the vital statistics of the city, the state or the nation.

But the difficulties involved! To be sure there will be some difficulty in securing such statistics, and considerable labor as well. But they are not insuperable; they are not so difficult as may be supposed. Such data are already available in many schools. I have direct information as to the existence of such data in the schools of Pittsburgh, Rochester, New York City and others, where for several years these facts have been critically compiled and filed as a part of the records of the schools, just as are data of grades, etc. One condition which greatly lessens the supposed difficulty of such vital records is that of medical school inspection. This has now become a recognized part of all progressive school direction. And while as yet it may be chiefly concerned with such physical problems as teeth, tonsils, nose, eyes, ears, etc., yet there is no good reason why it may not include some note of mental traits, idiosyncrasies, etc. But further, it is now well known that in some of the better schools there are already provided child-study laboratories equipped with all necessary facilities for critically measuring mental qualities, among which are inquiries into heredity and antecedents.

Now to revert to the question of educational betterment. Let it be recognized at once that education is not *creator,* but *guide.* Educability is largely a question of innate mental constitution, which fundamentally is determined by brain structure and its correlations. Hitherto our only means of forming an estimate of educability has been that of experiment. Try out the subject by a dozen years of school life; then pass him on to the college; possibly what the schools failed to do some academic legerdemain of a college pro-

fessor may achieve! But the experiment usually serves only to continue through four years further a task which a brief glance through the school pedigree would have shown to be hopeless against hope. Education must in some way have its basis of selection and differentiation no less efficient than has been that of organic nature. One of the most hopeful of these means, so far as the writer can perceive, is through what may be designated as educational eugenics, the application of the principles of eugenics to problems of mind to the function of the schools, and preeminently to the college and university, in the same general way through which we are presuming to secure better social and racial germ plasms.

Assuming what is now generally conceded, that all human characteristics are inherited in probably equal degree, and this must include mental traits and aptitudes, then it is not utopian to anticipate the existence of potentialities of intellect which it may be possible to distinguish early in development, if indeed they may not be predicted on some basis such as Mendelism, and which may serve as an index of fitness for or against prospective scholastic eminence of such nature as to warrant encouragement or inhibition, as the case may be. This does not imply that all educational effort need be intercepted; to the contrary, it means rather differentiation of aims and methods. One may give no promise whatever of fitness for distinctively literary or scientific or pedagogical education, yet may be safely directed toward technical, vocational or industrial education. In other words, our program, like that of eugenics in general, should be selective in both a positive and a negative sense; fitness should be sought and fostered in every reasonable way, while the unfit should be deflected or diverted into avenues in which some outlook may prompt specialized training adapted to such betterment as may be within realization.

Let me close as I began, with a call for ampler and more critical vital statistics. They are needed in almost every phase of our complex modern social and civil life. They can be made contributory to health, to moral and social conservation, and, as it seems to me, to educational progress toward a degree of efficiency and excellence for which it will no longer be necessary to apologize or explain.

Chas. W. Hargitt

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TO TRACE THE LINES OF FORCE IN AN ELECTROSTATIC FIELD

Mr. R. F. D'Arcy describes an arrangement for tracing the lines of force of an electrostatic field in *Nature*, of March 20. Mr. D'Arcy's method is to support a metal ball at the top of a tall glass tube standing upon a float in a tray of mercury. Then, according to Mr. D'Arcy, the insulated ball follows the horizontal lines of force of the electric field between the properly placed terminals of a large electric machine.

Another method for tracing the lines of force in an electric field is described by Mr. B. M. Neville in *Nature* of April 3. Mr. Neville simply allows a scrap of cotton-wool to fall between the knobs of an electric machine. As soon as the bit of cotton-wool touches one of the terminals it becomes charged and moves off rapidly along a line of force.

The most satisfactory method known to the writer for tracing the lines of force in an electrostatic field is to suspend a toothpick by fine thread from the end of a long handle. When placed in the electric field the suspended toothpick behaves exactly like a compass in a magnetic field, and points in the direction of the field.

The method suggested by Mr. D'Arcy is open to the objection that an insulated metal ball does not, in general, tend to move along the lines of force in an electric field. The objection to Mr. Neville's arrangement is that the piece of cotton-wool moves too rapidly.

W. S. Franklin

HIGH SCHOOL BOTANY

The fact that an idea is a decade old is not necessarily a recommendation for it; but if it

remains in use after that time it is evident that it has worn well in at least one person's head. The present standard secondary course in botany has been in use in a large part of the United States for somewhat more than that time. At about the time it congealed into a fixed and generally understood course, I was teaching both college and preparatory botany in the University of West Virginia. As a teacher of botany, I was naturally much interested in the subject and took advantage of every opportunity to examine its workings. At the same time, I took care that none of my own students failed to get a decent familiarity with botany as it had previously been taught in the high schools; that is, with a knowledge of the flowering plants growing in the vicinity. As to the wisdom of including the study of individual flowering plants, my opinion has grown stronger with the years.

During the last seven years I have seen and overseen a very large amount of botanical teaching, including the work of more than twenty teachers. In two high schools and in the work given students of high school grade in the College of Agriculture of the University of the Philippines, the course has been as outlined in Bulletin 24 of the Insular Bureau of Education. This course is really general botany, including the general facts and principles of morphology and physiology, including also drill in the determination of plants by means of keys, and the preparation of an herbarium of fifty determined species. In a considerable number of high schools where the teachers had had the usual first year of college botany and no other preparation in the subject, the outline in this bulletin was found not to be an adequate guide for their work, and the course given was accordingly as near as they could come to the standard high school course, with the help of one or another of the texts in most general use in the States. All possible assistance, including the distribution of numerous determined plants, was given these teachers, in the attempt to make their teaching "alive." So much depends upon the teaching ability of the teacher that a comparison of results even when judgment is based on familiarity with the subsequent work of a large number of students is not sure to be fair. But it certainly has been the case here that the students who were given instruction modeled after the standard American course have on the whole proved less interested in the subject, and less familiar with it, than those whose course had followed the local outline.

The students in the latter course get a first-hand knowledge of the plant cell, of the characteristic tissues of the higher plants, and of some of the typical plants illustrating the course of evolution. They learn accuracy, if the teacher teaches it, very much as they would in some other course. They are taught to think; enough for instance to be able to explain why the great groups of plants are characterized by their reproductive structures. They get a better idea of the variety and resourcefulness of nature than American students can be given, but this is because so many of the things we used to have to take on faith are growing about them. Also, and this is the characteristic of the course, each student becomes better acquainted with a considerable number of plants which he is already used to seeing, by determining them with a key and preparing them for his herbarium.

The teaching of botany should serve several uses. It should teach accuracy in observation and in depiction. It should help to create the habit of accurate thought. It should equip the students with a considerable amount of practical information. It should also give them an interest in the subject, which will stay with them after they get their credit and leave the class room. The standard course is essentially inadequate in two respects. It does not convey such information, which will be useful to many of those who have taken it, as it well might do. And it does not give the majority of those who take it an interest in the subject which will abide with them. The reason for the latter failure is that the course does not deal as it should do with things which are already familiar and interesting to the student, and does not include exercises of a kind which most of the students can have anything to do with after they leave school.

An interest in plants is a natural one. Plants are everywhere about us, and are useful in many and exceedingly important ways. The botanical teaching of the last ten or fifteen years has been missing its opportunity to serve and take advantage of this interest, by busying itself too exclusively with plants which most people never see except in the class room, and in which they have no practical interest.

The old course of study made better use in many respects of one term than the newer course has done of a year. It left much to be desired and the newer course made up its shortcomings; but it did this at too great an expense when it threw away the familiarity with the different kinds of common flowering plants, and the excursions, and the love of the woods which the students gained in old-time classes. There are hopeful signs of a backward swing of the pendulum. And it is well that this come before field botany is quite forgotten.

E. B. Copeland

INDOOR HUMIDITY

To the Editor of Science: Notwithstanding the conclusions reached in Dr. Ingersoll's interesting letter on this topic, something may perhaps be said in favor of a humidity considerably higher than 40 per cent., and nearer the 66 or 70 per cent. favored by "most authorities."

The writer has made experiments similar to those of Dr. Ingersoll, but with the following differences: gallons evaporated per day, 18 to 20, instead of 25 or more; volume of house actually served by the hot and humid air supply, 17,000 instead of 20,000 cubic feet; humidity maintained with comfort, over 60 per cent., instead of 40 per cent. Another important factor, and there are yet more, is that of house temperature. Unfortunately, Dr. Ingersoll has omitted any mention of this; but, judging from common American practise, one may, perhaps, assume a day temperature of 70°. Now in a Scots household, such as the writer's, a temperature nearer 60° is thought more comfortable, and was that aimed at in our experiments. And herein enters the most interesting feature of the case, that the weight of water present per cubic foot, and hence the possible amount of dew deposit, is approximately the same with 40 per cent. saturation at 70° as with 60 per cent. saturation at 60°! Thus, after all, those at least of the authorities that are European may not be so far wrong in their estimate, and, truly, one does like to say a little, if only occasionally, in favor of the authorities.

The writer would agree most heartily with Dr. Ingersoll in the statement that any serious effort to raise the indoor humidity is very well worth while.

Alan W. C. Menzies

Oberlin, Ohio

SCIENTIFIC BOOKS

The Purchasing Power of Money; Its Determination and Relation to Credit, Interest and Crises. By Irving Fisher, assisted by Harry G. Brown. New York, The Macmillan Company. 1911. Pp. xxii + 505.

Although Irving Fisher is a good propagandist and can use arguments which appeal to the man in the street, his reasoning is based upon critical, logical, scientific analysis. One of the propositions which he has recently been actively promoting is international monetary reform looking toward the elimination or restriction of those disastrously wide variations in prices which may be due to the irregularities of the world's gold production. The principles upon which his suggestions for regulating the general price level are based are expounded in his "Purchasing Power of Money." An early proficiency in mathematics and interest in the mathematical theory of prices has led him naturally to a quantitative or quantity theory of money which he builds up with a deep knowledge and appreciation of scientific method. This attitude is a justification for Science to show an interest in his work which it could hardly exhibit in the case of ordinary studies in economics.

Fisher starts from the obvious identity that what is spent per annum is equal to what is spent. If E be expenditure in cash and E' expenditure by check, we have

$$E + E' = (E + E').$$

Now if M be the amount of money in circulation, the average velocity V of circulation or rate of turnover of this money per annum may be defined by the equation

$$E = MV;$$

and if M' be the amount of deposits subject to check, the average velocity V' of turnover of deposits may be defined by

$$E' = M'V'.$$

Further, if Q_i be the quantity of a substance i which is bought and p_i the price, p_iQ_i will be the amount spent in this transaction. Total expenditure $(E + E')$ during the year will be the sum Σp_iQ_i of the various products p_iQ_i for the transactions of the year; or

$$(E + E') = \Sigma p_iQ_i.$$

This equation may be modified by the introduction of the total trade T for the year and the average price P. Then

$$\Sigma p_iQ_i = PT,$$

and the fundamental identity becomes

$$MV + M'V' = PT, \qquad (1)$$

which is *the equation of exchange*[1] (Chaps. I.-III.).

Such a mathematical identity is, as every one knows, a mere truism whose validity nobody should be rash enough to dispute. It might therefore be thought, and it is apparently the idea of many, that, being a truism, the equation is worthless, that nothing more can be obtained from it than has been put into it. This opinion has been somewhat of a stumbling block relative to all mathematics, and even such a prince of mathematicians as Poincaré did not think it beneath him, in his philosophizing moments, to try to explain why mathematics can really amount to something, why it does give results which are valuable, why it is really creative. We need not enter upon that question here; we may admit that by proper discussion and transformation mathematical identities do reveal important relations not obvious in the original form of the identity. Let us admit the same in regard to the identity (1).

We now have under our eyes six separate elements, M, M', V, V', P, T, entering into the equation of exchange, and we may focus our attention upon the effects produced upon certain of these elements by supposed variations in the others. For instance, if the amount of trade T and the velocities V, V' of circulation of money and deposits remain constant from year to year while the amounts of money M and of deposits M' increase, it follows indubitably that the general price level P must rise. On the other hand, if M, M', V, V' remain constant while trade increases, the level of prices must be lowered. As a matter of fact the statistics for the United States for 1896 and 1912 are as follows:

	M	M'	V	V'	T	P
1896 ...	0.88	2.71	18.8	36.6	191	60.3
1912 ...	1.70	8.15	21.0	53.0	435	107.6

If we regard the price level P as the passive element, the effect, and the other elements as causes,[2] we shall attribute the rise in the price level chiefly to the great increases in deposits subject to check and in their velocity; for the product MV has about kept pace with the increase in trade, whereas $M'V'$ has greatly outstripped it.

When it is a question of such actual figures as these, we have reached a stage somewhat remote from the equation (1) in the sense in which it was originally set up. Originally MV stood merely for the expenditures

[1] This simple form of the equation applies only to self-contained communities where each transaction is settled during the year. The author, however, discusses (p. 370 ff.) the modifications necessary when unsettled accounts and intercommunal trade are present, and comes to the conclusion that the changes are insignificant in the case of the United States.

[2] The author gives reasons to justify this assumption.

E of cash, which would naturally be impossible to calculate directly; now MV stands for an estimate of these expenditures obtained by a searching analysis of available financial data; that is, the evaluation of E is indirect. The same is true of $M'V'$ and E'. And the elements P and T are likewise found by diligent compilation and discussion of commercial data instead of by direct quest among the buyers and sellers. Such a change of aspect is found constantly in the correlation of theoretical and experimental physics. An equation is set up by a series of definitions or demonstrations. No amount of data can prove the equation; its validity is *a priori*. But the need of an experimental verification of the equation is none the less great; for in the applications to practical problems it is precisely such experimental data which must be used in the equation; and unless proper means of evaluating the terms of the equation are found, the importance of the theory is nil.

The author examines in lucid detail the various interrelations of the six elements which enter the equation of exchange. He comes to the conclusion that normally the element P may be regarded as passive, as the effect of the other elements, and that normally the ratio M'/M of deposits to circulation tends to constancy. He then goes on to an exhaustive discussion of what happens in transition periods where prices are rapidly rising (or falling) and where a certain amount of abnormality enters (Chap. IV.). The use of the word normally in the statement that normally the ratio M'/M tends to constancy seems rather unfortunate. The ratio M'/M has increased more or less steadily[3] for the United States from 3.1 in 1896 to 4.8 in 1912, and according to the author's estimate[4] for the whole gold-standard world the ratio will increase from 1.25 in 1911 to 2.25 in 1926. Thus the whole period of thirty years must be regarded as abnormal. With this use of the word it might well be that most periods are abnormal. We would not dispute that in the cycles between successive crises there should be certain periodic variations of the ratio, and that sudden changes in the world's gold production should bring about other erratic variations, and it is these two things that the author seems chiefly to have in mind; but it seems evident that a certain secular increase in M'/M should be expected to accompany normal advances in banking facilities and the attendant increase in use of these facilities by the public.[5]

The refined quantity theory of money is contained in the equation (1) where all the elements except P are considered as independent variables; it is a much cruder theory which is based upon the assumed constancy of M'/M. No careful reader of Fisher's work will fall into any crude errors or attribute such errors to the author; but there are enough careless readers, who may seize upon the phrase "quantity theory of money" and be led into useless discussion forgetful of the developments of Chaps. VIII. and XII., that we could wish the author had made less of the "normal" dependence of M' on M. Those who will but observe that in the equation of exchange for 1896 the term $M'V'$ was about six times as great as MV, and in 1912 about twelve times as great, will see the great danger and instability introduced into the system by making the preponderating term depend upon the small one.

The ascription of the rapid rise of prices during the past fifteen years to the great flood of gold has become increasingly popular of late, particularly since the impressive symposium on the subject in the first volume of *Moody's Magazine*. A facile argument may be constructed, namely, that the more gold we have relative to other possessions the less valuable is any given amount of it to us and the

[3] In the table on p. 304 the value 7.77 for M' for 1904 seems to upset the steadiness; but this number should obviously be 5.77.

[4] *American Economic Review*, September, 1912.

[5] A leading trust company says that now ten women have a check account where only a few years ago only two had one, and uses this fact to attract further accounts.

more readily will we exchange it for other goods; hence prices of other goods, as measured in gold, must rise. Such an argument does not introduce the equation of exchange; it is based on a sort of value theory of gold, partly quantitative, but largely psychological. We must not forget that according to theoretical economics the equilibrium of exchanges and the relative prices of goods do depend on the marginal utilities of the goods, that is, upon the relative values of the final infinitesimal quantities of goods entering into the exchange as these values are estimated by the individual traders. The value theory or, better, the marginal utility theory is therefore fundamental and the above mentioned facile argument is qualitatively correct.

When, however, we desire to take the equation of exchange as fundamental and for a quantitative discussion this seems the readiest if not the only thing to do, we have to examine merely the effects of a flood of gold upon the various elements of that equation. Suppose that 258 grains of standard gold are mined and turned over to the government for coinage into \$10 or for exchange for a gold certificate of like amount. Then M is thereby increased to the extent of \$10. As V is about 20, there is a contribution of some \$200 to the product PT. If a half billion of gold were thus injected into the circulation in the United States each year, it would cause an increase of ten billion in PT. Now in recent years trade has been increasing here in the United States at the rate of some fifteen billions per year. The half billion of gold, practically the total world output per year, would therefore not suffice to maintain prices, to say nothing of advancing them, here in our own country if we added all of it to the circulation, and provided, of course, that we did not otherwise inflate the circulation.

Suppose, however, that the 258 grains of gold went into the reserves of a bank operating under a rule of 25 per cent. reserve against deposits. The quantity M' would then be swelled not merely by \$10, but by \$40, and as V' is in the neighborhood of 50, the term $M'V'$ would be increased by something like \$2,000, ten times as much as the term MV was increased on the previous hypothesis. Hence an addition of 75 millions in gold to the reserve stocks of banks operating under a 25 per cent. ratio would swell the term $M'V'$ by the fifteen billion requisite to keep pace with trade, and a greater increase of gold would more than keep the pace, it would force prices to rise. These figures are very rough and are cited merely to enforce the idea that it is the expansion of credit by the influx of gold into bank reserves, and not the increase of gold in circulation, which must be the chief cause in the rise of prices as determined by the equation of exchange. We make no attempt to take secondary effects into consideration.

In the last chapter of the work the author discusses the possibility of stabilizing the purchasing power of the dollar, that is, of maintaining an approximately constant price level. The scheme he there suggests for accomplishing this purpose has undergone successive modifications in a considerable series of printed papers or privately circulated monographs until its present form appears in an article only two months old.[6] Unfortunately he abandons his equation of exchange and proceeds with general arguments or special hypotheses which seem far from substantial foundation. Such a change in style may be necessary to make an impression on a general public, and it is only by making such a general impression that any actual change of standard of value could be made into law; but for a mathematician the way would have been better lighted had the equation of exchange been constantly in evidence.

Briefly, the plan is to have the various gold-standard governments of the world pay less for gold as the general level of prices rises. Thus instead of giving a dollar for 25.8 grains of coin-gold, the United States would require 27 or 30 grains in exchange for a dollar. The author has an elaborately worked

[6] "A Compensated Dollar," *Quarterly Journal of Economics*, Vol. 27, February, 1913.

out plan for changing the price of gold and for preventing the government from being at the mercy of gold speculators. He gives detailed tables and charts to show what, on certain assumptions, would have been the results if his system had been in operation for certain periods of years. His suggestions have called forth a very large number of commendatory comments from a great variety of persons eminently able to judge of their value from many diverse points of view. There seems to have been but small adverse criticism from any quarter. As for ourselves, untrained in such matters and deprived of the direct guidance of the equation of exchange, we will acknowledge that a bewildering vacillation is in possession of us, swinging us now to complete confidence in the plan, and again to absolute distrust of it.

At the present moment we are extremely pessimistic about the efficacy of Dr. Fisher's remedy. Statistics show very well that the term in the equation of exchange which causes the trouble is $M'V'$. To keep prices constant we have to keep the increase of $M'V'$ sensibly equal to the increase of trade. Now if a gold miner has to take fewer dollars from the government for a given amount of gold, there is a slight diminishing of the increase of M, and if he deposits the gold certificate subject to check, there is a slight reduction of the increase of M'. But these small alterations of the increases of M or M' would make only an insignificant effect upon the equation of exchange. Of course, if the price of gold were lowered enough to shut down some of the gold mines, the effect would be of considerable magnitude, and thus ultimately the regulation might be accomplished. But this would be at a very much altered price of gold; for gold mining is a pretty profitable business. Moreover, it would probably be an extremely unstable stabilization of the dollar; we have only to look at the market for copper metal over a long series of years to see how violent are the swings of prices when regulation of demand and supply takes place through the closing down or opening up of the less efficient mines.

When the government requires more gold for a dollar all the gold certificates outstanding, though presumably redeemable in the new ratio for gold, are actually backed by less than the requisite amount. Within moderate limits there would be, as the author says, no danger in this arrangement. Indeed, there has been at times a great cry against the wastefulness of gold practised by the United States in keeping a great hoard at par with the gold certificates,[7] whereas if the gold were available for banking purposes, it would serve as the basis of an enormous credit. But this is precisely what we do not want if we are intent on keeping prices down. It would add much to the possible efficacy of Fisher's regulatory plan if the government were required to maintain all the gold certificates at par with the new weight of gold. The author, however, specifically states that this need not be required. The matter is not so important as it might be, owing to the smallness of the term MV in the equation of exchange.

What about the banks? If the government is not to keep its certificates at par with the new figure for gold, are the banks to be compelled to compute their percentage gold reserve on the new basis? If so, the scheme is not very sure of enthusiastic support from bankers. For instance, if a banker has deposits of one million dollars on which he must keep a reserve of 20 per cent. in gold, he has a reserve of \$200,000, or 5,160,000 grains in gold, at the present exchange ratio of 25.8 grains to the dollar. If the ratio is altered to 25.9 grains to the dollar and he is still required to keep a 20 per cent. reserve, he must add 200,000 grains, or \$775, at the old evaluation, to his reserve. This, so far as he is immediately concerned, is equivalent to leaving the exchange ratio for gold unchanged and raising his gold-reserve requirement to 20.0775 per cent. This would undoubtedly have the

[7] We believe we are right in saying that R. Goodbody once suggested that some of the evils of our inelastic currency system could be alleviated, if not remedied, by calling in the certificates and paying out the gold.

effect of absorbing to a certain extent the present oversupply of gold. It would scarcely be effective in keeping down the average price level until a far greater rise in the effective reserve requirement had been made.

The calculations by which the author shows that had his system been in vogue during the last few years the price level would have remained sensibly constant are based upon the assumption that a one per cent. rise in the amount of gold demanded for a dollar brings about a one per cent. fall in the price level. On a certain vague value theory of money this may appear reasonable, but from the point of view of the equation of exchange it is far from obvious. The one thing we must bear in mind is that $M'V'$ must be kept under control, and to a less extent MV. The author would have done much better to stick to his equation and calculate what effect his proposition would have had upon the changes in $M'V'$. That would have been more scientific.

Lowering the price of gold could diminish the increase of M' in three ways. First, by slackening the output. The lowering would probably have to go a long way, however, before the slackening became considerable. Second, by diverting gold from banking uses into the arts. Whether the arts, which now consume only about one third the annual output as against two thirds which goes to monetary and banking uses, could well absorb a much greater quantity of gold unless the price were very much lowered is not evident. Third, by augmenting the effective reserve requirements, as above explained. What we must have is some sort of a sink for gold. Indeed, it occurs to us to suggest that without at all disturbing the ratio of exchange between gold and dollars, we could accomplish the desired regulation of prices by insisting upon the strengthening of reserves. Suppose all banks receiving deposits subject to check were compelled to maintain a 50 per cent. reserve on all new business beginning with 1914. An increase of 15 billions in trade would then call for 150 millions in gold instead of the much smaller amount at present required. To make banking less profitable and safer might be easier and more directly effective than to discourage gold mining.

So much attention has been devoted to Fisher's plan for regulating the price level because the subject is actively under discussion all over the world, because Fisher has failed to maintain the scientific excellence with which he started out, and because he has apparently developed a method of attack which is better and surer than the one he uses. In view, however, of the almost unanimous indorsement he has received we feel very apologetic about these criticisms we offer.

Some parts of the work we have scarcely touched upon, parts which from a scientific point of view might seem to merit more notice in this weekly than the parts we have discussed. For instance, there is in Chap. X. an analysis of the best index numbers of purchasing power and in an appendix a masterly analytical treatment of the various types of index numbers which show the defects and the advantages of different types for different purposes. And in general there is much of excellent scientific value throughout the appendices. But we must pass it by, as we do much of the historical matter (Chap. VII.), and the discussion of indirect influences which exert secondary effects on the equation of exchange (Chaps. V.–VI.).

The arrangement of the book is very thoughtful toward the reader. Not only are the table of contents and the index exceptionally full, but there is a little foreword wherein readers of different types are instructed as to where they will find what they in particular are looking for. The mathematical work is relegated to the appendices, and so are the more subtle developments. The book should be read by everybody at all interested in any of the questions it treats.

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The Mesozoic Flora of Graham Land. By T. G. HALLE. Wissenschaftliche Ergebnisse d. Schwedischen Süd-polar-Expedition, 1901–

1903. Bd. III., Lief. 14. Pp. 123. Pls. IX. Stockholm. 1913.

The recent renewed interest in Antarctic exploration, the discovery of the South Pole, the unfortunate fatality attending the English expedition, etc., have focused attention on this *terra incognita*. There is in this region so much in the way of possibility as regards the origins of floras and faunas, centers of distribution, and possible migration routes, that everything which tends to throw light on its past life is likely to prove of absorbing interest, and in this connection it is a pleasure to note the appearance of Dr. Halle's splendid memoir on the Mesozoic flora of Graham Land which is the first Mesozoic flora known from the Antarctic. Previous to the work of the Swedish South Polar Expedition our knowledge of the ancient Antarctic vegetation was extremely limited. The present report is based on a very large collection made, it is said, under conditions of the greatest hardship, by Dr. J. G. Anderson at Hope Bay, Graham Land. The material came from a single series of hard, dark, slaty rocks and is regarded as Middle Jurassic in age. The flora embraces 61 forms of which, however, nearly 20 have not been given specific names. They are distributed among the several groups as follows: Filicales 25; Cycadales 17; Coniferales 16; unknown 3. It is of interest to note that the Ginkgoales, which are so important and varied an element in the northern hemisphere, are entirely absent in the Antarctic, as indeed they are in the Gondwanas of India. *Podozamites,* which is so abundant and variable in the north, is absent from the Hope Bay collection and is represented only by fragments in the Indian localities. Cycads are abundantly present at Hope Bay but they are all small-leafed species, while the conifers were abundant in materials but not well preserved.

Although the author has made quite a number of new species—on the wise basis that it is better to give a new name that may ultimately become a synonym, than to lump doubtful material under an old name that later may have to be divided—there are no less than 22 species previously known. Of these, 9 species are common to the Lower Oolites of England, 8 to the Upper Gondwanas of India, and 5 to the Jurassic of California and Oregon, with others which are scattered at various well-known Jurassic localities. The close relation existing between the Jurassic flora of Graham Land and other contemporaneous floras is certainly remarkable when considered in regard to its remoteness from these floras. In the nearest continent, South America, there are no floras of any importance that can be considered contemporaneous with the Antarctic one. Dr. Halle concludes as follows: "Though the closest argument is with the Jurassic flora of England, the resemblance to the Indian Upper Gondwana flora is nearly as great. The Hope Bay flora tends thereby to lessen yet more the differences between these floras and thus becomes another important illustration of the uniformity and world-wide distribution of Jurassic floras. This uniformity is all the more striking because of the pronounced differentiation of the world's vegetation into two different phyto-geographical provinces at the end of the Paleozoic, which difference would appear to have become almost extinguished in Jurassic time."

F. H. Knowlton

SPECIAL ARTICLES

THE PHYSICO-CHEMICAL CONDITIONS OF ANESTHETIC ACTION. CORRELATION BETWEEN THE ANTI-STIMULATING AND THE ANTI-CYTOLYTIC ACTION OF ANESTHETICS

The anti-stimulating action of lipoid-solvent and other anesthetics is well known. Irritable tissues become temporarily irresponsive when exposed to solutions of these substances in certain concentrations, which must not be too high—otherwise cytolysis results, or too low—in which case irritability may be increased instead of decreased. The precise nature of the change in the irritable elements conditioning the loss of irritability remains obscure. The Overton-Meyer theory refers

anesthesia to a modification of the lipoids. But a reversible loss of irritability similar in all essential respects to anesthesia may be induced by substances which have no specific relation to lipoids—as salts of magnesium or calcium, acids in low concentration, non-electrolytes like sugar—and also by the electric current (anelectrotonus). From these facts we must infer that although a change of state in the cell-lipoids may induce anesthesia it is not the essential change. Some other more general process is involved. What is the nature of this process?

In studying the conditions of chemical stimulation in the larvæ of *Arenicola*—a free-swimming annelid trochophore, 0.3 millimeters long and abundant at Woods Hole—I was struck with the fact that solutions which stimulate the musculature powerfully, causing strong and persistent shortening to half the normal length, invariably cause an immediate and marked exit of pigment from the body cells. Among such solutions are pure isotonic solutions of sodium and potassium salts. The cells of the larvæ contain a yellow water-soluble pigment, which on death, or under other conditions associated with increased permeability of the plasma membranes (action of cytolytic substances, as saponin), diffuses into the medium and colors the latter a bright yellow. This pigment thus serves as a convenient indicator of permeability-increase. The strong stimulation caused by isotonic NaCl solution is thus associated with a marked permeability-increasing action. This is equivalent to a cytolytic or toxic action, for definite toxic effects, as shown by breakdown of cilia and failure of the larvæ to revive completely on return to normal sea-water, always follow even brief exposure to the pure NaCl solution. The stimulating, permeability-increasing and cytolytic actions of the solution thus show a definite parallelism.

Conditions that prevent the immediate stimulating action also prevent the permeability-increasing and toxic action. Addition of a little calcium or magnesium chloride, *e. g.*, to the NaCl solution has this effect. In such mixed solutions there is little or no immediate stimulation or loss of pigment and the toxic action is greatly diminished. Stimulation and permeability-increase, with the associated toxic or cytolytic action, are thus simultaneously prevented by the calcium or other antagonistic salt.

Similar effects are seen if the organisms are briefly treated with magnesium chloride *previously* to being brought into the NaCl solution. Isotonic $MgCl_2$ solution causes neither stimulation nor loss of pigment. The musculature is rapidly anesthetized in this solution, and the animals remain rigid and without contraction, swimming slowly by the cilia which remain active. If the larvæ are then transferred to $m/2$ NaCl no immediate effect is seen. Stimulation and loss of pigment are entirely absent, and correspondingly there is little immediate toxic action. The treatment with $MgCl_2$ has a protective or anti-cytolytic as well as an anesthetic or anti-stimulating (desensitizing) effect.

Similar effects are produced by lipoid-solvent anesthetics. Larvæ exposed to a 0.7 v. per cent. solution of ether in sea-water are rapidly anesthetized. If then they are brought suddenly into pure $m/2$ NaCl containing the same proportion of ether, no stimulation or permeability-increase is seen, and the toxic action is diminished as before; *i. e.*, recovery on return to sea-water is much prompter and more complete than after similar exposure to pure $m/2$ NaCl without previous anesthetization. Direct transfer from normal sea-water to ether-containing salt-solution also causes little or no stimulation or loss of pigment. The anti-stimulating action in this case also is associated with or involves a marked anti-toxic action.

I have performed similar experiments with a large number of other anesthetics with the same general results.[1] In those concentrations which in sea-water produce typical reversible anesthesia, the anesthetic checks or prevents the immediate stimulating action of the salt

[1] For a detailed account of these experiments *cf. American Journal of Physiology*, 1913, Vol. 31, pp. 264 seq.

solution, and also its permeability-increasing action as indicated by loss of pigment. A corresponding anti-cytolytic or anti-toxic action is invariably found to be associated with these effects.

The following anesthetics have been used in these experiments: *alcohols:* methyl, ethyl, n-propyl, isopropyl, n-butyl, n-amyl, n-capryl; *esters:* ethyl acetate, propionate, butyrate, valerianate, nitrate; *urethanes:* methyl, ethyl, phenyl; chloroform, carbon tetrachloride, nitromethane, acetonitrile, benzol, toluol, xylol, phenanthrene, naphthalene; ethyl ether, chloretone, chloral hydrate, chloralose, paraldehyde, phenyl urea, acetanilide, phenacetin, methacetin.

Almost all of these substances have also been used by Overton in his investigations of anesthesia in tadpoles. In the case of *Arenicola* larvæ the concentrations requisite for neuromuscular anesthesia are in all cases higher (usually from three to five times higher) than for the neuromuscular system of Vertebrata. Otherwise the relations observed in these experiments are closely similar to those found by Overton and other experimenters in this field. For homologous series (alcohols, esters) the anesthetic action increases regularly with the molecular weight—*i. e.,* with the lipoid-water partition coefficient. The anti-cytolytic or protective action always runs closely parallel with the anti-stimulating action. A well-marked protective effect is however often seen in concentrations which are insufficient for complete anesthesia.

The general fact that the anesthetic hinders or prevents increase of permeability indicates that the seat of its *essential action is in the plasma-membranes of the irritable tissue.* The characteristic permeability of the plasma-membranes of cells to lipoid-soluble substances furnishes strong evidence that these membranes consist largely of lipoid material. The lipoid-solvents alter the membrane by changing the state of its lipoid components; other substances may produce similar effects by changing the state of the other colloids of the membrane. In general these observations show that anesthesia is associated with an increase in the resistance of the membrane to the permeability-increasing action of the stimulating agency. I infer, therefore, that the essential condition of anesthetic action is a modification of the physical properties of the plasma membranes of the irritable elements, of such a kind that the membranes fail to undergo, under the usual conditions of stimulation, the increase of permeability essential to this process. This modification may be caused by lipoid-solvents, salts or other substances; also by altering the electrical polarization of the membrane by an external electric current, as in anelectrotonus. Apparently any condition that renders the membrane incapable of rapid and reversible changes of permeability renders the tissue refractory to stimulation. On this view the parallelism between the antistimulating and anti-cytolytic actions becomes intelligible, since increased permeability is the condition of cytolysis as well as of stimulation. Substances or conditions that prevent the one effect will also prevent the other.

These observations have a direct bearing on the general theory of stimulation. They support the view that an essential feature of the stimulation-process is a well-marked increase in the permeability of the limiting membranes of the irritable elements. It is obvious that the problem of the nature of anesthetic action involves the problem of the nature of the stimulation-process, and study of the action of anesthetics thus forms one means of attacking this wider problem. Any constant physical modifications caused in the irritable elements by the anesthetic, coincidently with the loss of irritability, must furnish indications of the nature of the processes concerned in the response to stimulation. The above observations thus agree with those of Nernst and his successors, which localize the primary or critical process in stimulation at the semi-permeable membranes of the irritable elements. They indicate further that in stimulation the permeability of these membranes is increased. But changes of permeability must involve

changes in the electrical polarization of the membranes; and it seems probable that these variations in electrical polarization are more directly responsible for the characteristic special effects produced by stimulation—such as increased oxidation, contraction, and the other forms of response which vary from cell to cell.

RALPH S. LILLIE
UNIVERSITY OF PENNSYLVANIA

THE SOUTHERN SOCIETY FOR PHILOSOPHY AND PSYCHOLOGY

THE eighth annual meeting of the Southern Society for Philosophy and Psychology was held at the Johns Hopkins University, Baltimore, on Tuesday and Wednesday, April 8 and 9, 1913. Three sessions were held: one on Tuesday afternoon, one on Tuesday evening and one on Wednesday forenoon. On Tuesday afternoon at 5 o'clock the members of the society were invited to attend the university lectures on "Bergson's Doctrine of Time" given by Professor A. O. Lovejoy in the Donovan Room of McCoy Hall. The sessions were held in the lecture room of the biological laboratory, President R. M. Ogden presiding. The president's address, entitled "The Relation of Psychology to Philosophy and Education," was given at the session on Tuesday evening. Preceding this address, the local members of the society entertained the visiting members at a dinner at the Johns Hopkins Club, and after the address they entertained them at a smoker in the rooms of Professor Lovejoy. The following items were passed upon at the business meeting, which was held on Wednesday morning:

1. It was decided to hold the next meeting at Atlanta, Georgia, during the recess of the Christmas holidays, in conjunction with the meetings of the American Association for the Advancement of Science.

2. The following officers were elected for the year 1913: *President*, H. J. Pearce, Brenau College; *Vice-president*, A. O. Jovejoy, Johns Hopkins University; *Secretary-Treasurer*, W. C. Ruediger, The George Washington University; *Council for three years*, Bird T. Baldwin, Swarthmore College, and Josiah Morse, University of South Carolina.

3. The following were elected to membership: Professor W. H. Chase, University of North Carolina; Professor L. R. Geissler, University of Georgia; Miss H. B. Hubberd, Baltimore; Miss E. D. Keller, Baltimore; Dr. Frank A. Manny, Baltimore Training School; Professor Mark A. May, Murphy College; Father Thomas V. Moore, Catholic University of America; Mrs. Jacob Taubenhaus, Newark, Delaware; Mr. Jacob Ulrich, Baltimore; Professor H. H. Williams, University of North Carolina.

4. The accounts of the treasurer were audited by a committee of the council and showed a balance on hand, April 9, 1913, of $68.70.

5. Votes of thanks were extended to the authorities of the Johns Hopkins University for the use of the lecture room of the biological laboratory and to the local members for the dinner and the smoker.

W. C. RUEDIGER,
Secretary-Treasurer
THE GEORGE WASHINGTON UNIVERSITY,
WASHINGTON, D. C.

THE ZOOLOGICAL SECTION OF THE MICHIGAN ACADEMY OF SCIENCE

THE nineteenth annual meeting of the Zoological Section met in the zoological lecture room of the University of Michigan at 9 A.M. and 1:30 P.M. on April 3, with Vice-president Peter Okkelberg in the chair. The meetings were well attended and the following program was read. Dr. Bertram G. Smith, of the Ypsilanti State Normal College, was elected vice-president and chairman of the Zoological Section for the coming year. Hereafter the meetings will be held on the Friday and Saturday after Thanksgiving.

"Factors Governing Local Distribution of the Thysanoptera," A. F. Shull.

"Results of the Mershon Expedition to the Charity Islands, Lake Huron Coleoptera," A. W. Andrews.

"Types of Learning in Animals," J. F. Shepard.

"The Lepidoptera of the Douglas Lake Region, Cheboygan County, Michigan," Paul S. Welch.

"Check-list of Michigan Lepidoptera. II. Sphingidæ (Hawk-moths)," W. W. Newcomb.

"On the Breeding Habits of the Log-perch," Jacob Reighard.

"A List of the Fish of Douglas Lake, Cheboygan County, Mich., with notes on their Ecological Relations," Jacob Reighard.

"May the Remains of Adult Lepidoptera be Identified in the Stomach Contents of Birds?" F. C. Gates.

"The Mitochondria," R. W. Hegner.

"The Unione Fauna of the Great Lakes," Bryant Walker.

"An Adult *Diemyctylus* with Bifurcated Tail," B. G. Smith.

"Notes on the Mollusks of Kalamazoo County, Mich.," Harold Cummins.

"Sarcoptid Mites in the Cat," Harold Cummins.

"The Origin of Continental Forms, III.," Howard Baker.

"An Ecological Study of the Birds of Manchester, Mich.," F. Gaige.

"Notes on Crustacea Recently Acquired by the Museum of Natural History of the University of Michigan," A. S. Pearse.

"Distribution of Multiple Embryos on the Blastoderm," O. C. Glaser.

"Nesting of Our Wild Birds," Jefferson Butler.

"The Factors that Determine the Distribution of *Boleosoma nigrum* in Douglas Lake, Cheboygan County, Mich.," H. V. Heimburger.

"Pedogenesis in *Miastor americana* Felt.," R. W. Hegner.

"The Seminiferous Tubules in Mammals," G. M. Curtis.

"A Method of Producing Cell-like Structures by Artificial Means," E. W. Roberts.

"Some Notes on Rhizopods from Michigan," E. W. Roberts.

"Oxygen and Carbonic Acid Contents of Douglas Lake, Cheboygan County, Mich.," D. A. Tucker.

"Some Observations on *Asplanchna amphora*," D. A. Tucker.

"Some Abnormalities Observed in Proteocephalid Cestodes," G. LaRue.

"Some Observations on Intestinal Villi," O. M. Cope.

"Some Physiological Changes in the Lamprey Egg after Fertilization," P. Okkelberg.

"A Collection of Fish from Houghton County, Mich.," T. L. Hankinson.

"The Lagoons and Ponds of Douglas Lake, Cheboygan County, Mich.," H. B. Baker.

"The Shiras Expeditions to Whitefish Point, Mich." (1) "Birds," N. A. Wood. (2) "Mammals," N. A. Wood. (3) "Amphibians and Reptiles," Crystal Thompson and Helen Thompson.

"Notes on the Ornithology of Clay and Palo Alto Counties, Iowa," A. D. Tinker.

"A Check-list of Michigan Mammals," N. A. Wood.

"The Variations in the Number of Vertebræ and Ventral Scutes in the Genus *Regina*," Crystal Thompson.

"An Artificially Produced Increase in the Proportion of Male Producers in *Hydatina senta*," A. F. Shull.

R. W. Hegner,
Secretary

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES

The Section of Anthropology and Psychology met in conjunction with the New York Branch of the American Psychological Association on April 28, when the following program was presented:

Afternoon Session, at 4:10 P.M.

Mr. A. E. Rejall: "Binet Tests in Schools for Incorrigibles in New York City."

Mr. G. F. Williamson: "Some Individual Differences in Immediate Memory Span."

Miss Mabel Barret: "The Order of Merit Method and the Method of Paired Comparisons."

Dr. E. K. Strong: "Effect of Size and Frequency on Permanence of Impression."

Dinner at the Faculty Club of Columbia University, 6:00 P.M.

Evening Session, at 8:00 P.M.

Dr. Clara Jean Weidensall: "A Comparison of the Records of the Criminal Woman and the Working Child in a Series of Mental Tests."

Professor J. McK. Cattell: "Families of American Men of Science."

Dr. A. T. Poffenberger: "The Influence of Strychnine on Mental and Motor Efficiency."

PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA MATHEMATICAL AND SCIENTIFIC SECTION

The seventh meeting of the session of 1912-13 of the Mathematical and Scientific Section of the Philosophical Society was held April 22.

Mr. Justus H. Cline presented a paper by himself and Professor Thos. L. Watson, entitled "Normal Faulting in the Cambrian of Northern Virginia."

Professor Chas. Hancock presented a report on the "Plants of the Southern Power Company."

Professor J. S. Grasty read a paper, by himself and Professor Thos. L. Watson, on "Barite Deposits of the Southern States."

Wm. A. Kepner,
Secretary

University of Virginia